MACHINERY.

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ELECTRICALLY DRIVEN MACHINE TOOLS.—1.

DISCUSSION OF GENERAL PRINCIPLES, WITH ILLUSTRATIONS SHOWING APPLICATION OF MOTORS.

A. L. De Leeuw.

The electric drive for machine tools has come to stay. It is, however, still in a very unsettled condition. The number of things which are not known about this subject would fill a book. A motor in itself is quite a complex thing, so is a machine tool, generally speaking; and, of course, a combination of the two is more complex than either. It is my intention to point out some of the difficulties one meets when trying to apply a motor to a machine tool, and also some ways in which at least part of these difficulties may be overcome. In order to clearly understand these difficulties we must look at the requirements of machine tools, and at the limitations of the present-day motor.

No one would expect a steam engine to run at any speed, regardless of the speed for which the governor is set. No one would expect it to develop 100 horse power when it is designed for only 50 horse power; and no one would require it to run economically with 90 per cent cut-off if it is built for 30 per cent cut-off. This is quite natural, because we are fairly familiar with the steam engine. It is an old friend, whose value we appreciate and whom we do not despise for its shortcomings. But the motor is a newcomer; its advent has been announced in terms of the highest praise, and we naturally expect a great deal from it. In fact, we generally expect too much—more than we ever would expect of any other kind of prime mover. It is, therefore, perfectly natural that we should be disappointed once in a while.

Classes of Direct Current Motors.

Motors may be grouped in two classes—direct-current and alternating-current motors. The direct-current motors might be grouped again in three subdivisions according to the winding of the field magnets, namely: Series-wound, shunt-wound and compound-wound motors. It lies entirely outside the scope of this article to give even a brief outline of the properties of these various types of motors, but this much can be stated here: A series-wound motor has no fixed speed at which it runs; its speed decreases when the load increases. One might say, roughly speaking, that the product of speed and torque (that is, its horse power) is constant. It will start with almost any load, and it races when the load becomes too light. Its speed can be regulated by external resistance, but to do so requires an attendant who constantly watches the load and speed and who controls the resistance accordingly. It is a splendid motor for railroad or crane service, where such an attendant is always at hand; but a machine tool generally requires a motor which should be self-regulating. A series-wound motor, therefore, is ill-adapted for machine tools. There are a few cases, however, where such a motor can be successfully used, for instance, when some part of the machine tool, say, a carriage or tailstock on a long lathe, has to have a quick traverse. The load in this case is practically constant. The speed, therefore, will also be constant. Small variations in the load, on account of differences in the lubrication or wear, will cause slight variations in the speed; but this is immaterial in this case. It would be a mistake to think that a series-wound motor is equally well adapted for traversing parts of machine tools in a vertical plane, such as a cross rail of a planer or a boring mill. The difference in load going up or down is too great.

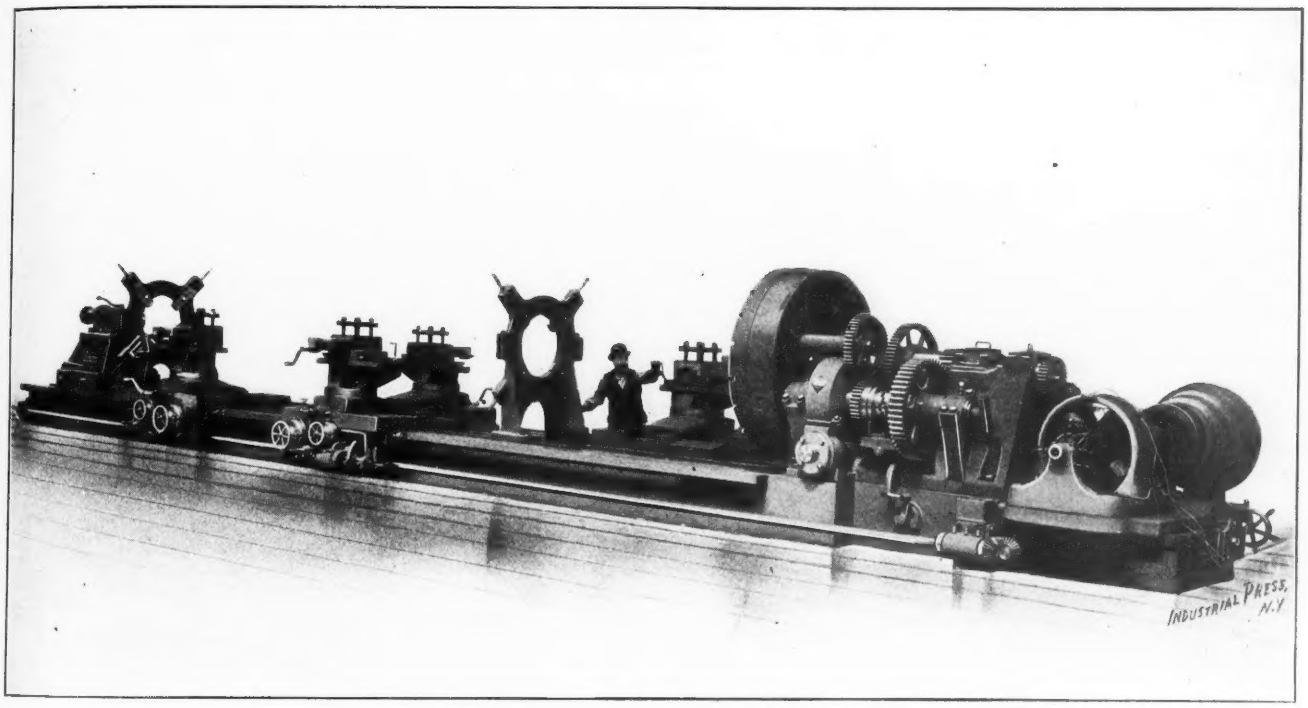


Fig. 1. Sixty-three Inch Niles Lathe with Four Carriages, Driven with 15 H. P. Motor.

The shunt-wound motor is self-regulating as to speed; that is, it keeps the same speed whatever may be the load. Like all my other statements about motors this statement is not absolutely true, but it is true enough for practical use. On account of its constant speed the shunt-wound motor is especially well adapted to drive machine tools which run at only one speed, or to drive countershafts. Its main draw-

back is that it has a low starting torque, which, however, is not quite so serious as it looks, as will be seen hereafter. The speed of a shunt-wound motor varies with the voltage; that is, the speed goes up when the voltage goes up, and vice versa. This fact is of very little importance as far as machine tools are concerned, as the fluctuations in voltage in any well-designed power plant are limited to a few per cent. There is one case, however, where this property of the shunt-wound motor becomes of the greatest importance to the machine tool builder, and that is where multiple voltage is used; but of this more later on. The speed of the shunt-wound motor can be changed in two ways: It can be speeded up by inserting resistance in the field winding—in which case the motor remains self-regulating under varying loads—or it can be slowed down by inserting resistance in the armature circuit, in which case it loses its property of self-regulation and behaves to a large extent like a series-wound motor. For this reason this mode of controlling a shunt-wound motor (rheostatic control) is of little use to the machine tool builder.

The compound-wound motor is a cross between the series-wound and the shunt-wound motors. Its fluctuations of speed under varying loads depend on the strength of its series coils as compared to the shunt coils. The same is true of its starting torque; consequently a compound-wound motor which has a large starting torque will also show great fluctuations of speed under a varying load. The compound-wound motor lends itself, therefore, to cases where a relatively large starting torque is required, and where a perfect constancy of speed is not essential; for instance, for the quick traverse of machine parts like the carriage on a lathe or the cross rail on a planer or boring mill, etc.

Alternating Current Motors.

Alternating-current motors might also be divided in three groups, viz.: Synchronous, multiphase and monocyclic. These classes embrace nearly, though not quite, all existing alternating motors. All these motors have a tendency to run in perfect synchronism with the generator or to within a few per cent of that speed, and they may, therefore, be considered as constant-speed motors. The synchronous motor is not well adapted to machine tools, as it is not self-starting. The multiphase and monocyclic motors are self-starting, and have a fairly large starting torque. They do not allow of speed regulation except by cutting out some of the poles or by rheostatic control. I do not know of any alternating-current motor in this country which is specially built with the purpose in view of running it at variable speed.

The above is a crude outline of the limiting qualities of motors. We now must look for the requirements of machine tools, and instead of trying to generalize it may be best to look at the different classes of machine tools as they now exist. Let us first look at the tool most familiar to all of us—the lathe—and especially the engine lathe.

Speed Changes for Motor-driven Lathes.

The ordinary engine lathe, as we all know, is driven by a belt running on a cone pulley, while in all larger sizes back gears are used to get the lower speeds and to increase the pull. This arrangement is very simple; it provides for a large range of speeds, and not only that, but as the speed decreases the pull, or rather the torque, increases. To more clearly show the possible results of such an arrangement we will assume a 24-inch lathe to have a cone, of which the large step is 18 inches in diameter, the small step is 9 inches in diameter, and the back gear ratio is 5 to 1. We will assume the countershaft to make 80 revolutions per minute, and we will further assume that the countershaft cone has the same steps as the machine cone. With this arrangement the lowest speed of the spindle would be 8 R. P. M., which speed is, of course, too high for a 24-inch lathe; but this does not matter here, as the figures have been chosen for illustration only and are not supposed to be used in designing a machine. This lowest speed is obtained by throwing the back gear in and putting the belt on the 18-inch step. If the diameter of the piece to be turned is smaller than 24 inches the belt is shifted from the highest to a lower step, leaving the back gear in mesh. By the time the belt is on the 9-inch step the spindle runs $80 \times \frac{18}{9} \div 5 = 32$ R. P. M. This would be the proper speed for about 6 inches diameter; at least, if 8 R. P. M. is the proper speed for 24 inches diameter. It will be seen, therefore, that, though the ratio between the highest and the lowest step of the cone is only 2 to 1, the ratio of diameters that can be cut by simply shifting the belt is 4 to 1. The belt speed changes when the belt is shifted from one step to the other and is highest when the belt is on the small step, because it is then on the largest step of the counter cone. It will be seen, therefore, that the lathe can do more work with the belt on the small step than with the belt on the large step. However, the torque of the lathe is greatest when the belt is on the large step, because the torque is in right proportion to the diameter of the steps.

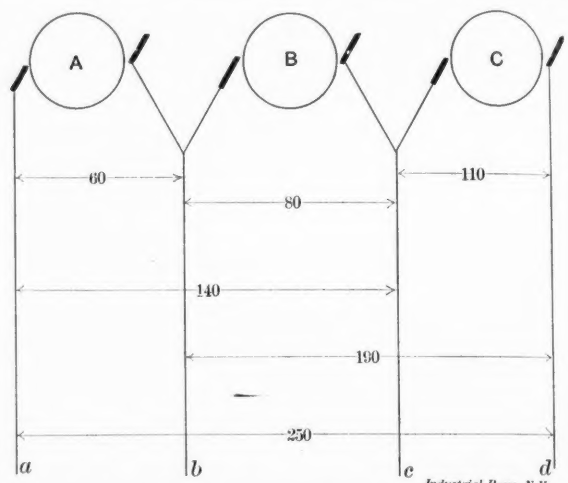


Fig. 2. Arrangement of Wires in Multiple Voltage System.

Let us illustrate this with figures. If this lathe should give a pull of 2,000 pounds on a diameter of 24 inches, then the torque is 2,000 × 12 = 24,000 inch-pounds. The work done by the lathe may be expressed by 8 × 24,000, because the spindle makes 8 R. P. M. When the belt is on the small step its speed is doubled; therefore, the work which can be done by the lathe is doubled, and is, therefore, 16 × 24,000 inch-pounds. The speed of the spindle, at the same time, was increased from 8 to 32 R. P. M.; so that the torque is now 16 × 24,000 ÷ 32 = 12,000 inch-pounds. This torque is available for cutting on a diameter of 6 inches; so that the pull at the circumference of a 6-inch piece is now 12,000 ÷ 3 = 4,000 pounds. This, however, is very much diminished by the increased friction in the lathe when it is run at higher speed. Taking it all in all, a belt and cone pulley are a close approach to an ideal arrangement for driving a lathe, allowing the lathe to run at speeds corresponding to the diameters to be turned and giving the greater torque for the larger piece.

Now, what kind of motor would we have to use if we should build it in the headstock of a lathe, making it take the place of a cone pulley? This motor would have to be a variable-speed motor, the lowest speed to be 40 R. P. M. and the highest 160 R. P. M. Its torque at the low speed must be four times greater than at the high speed, so as to give the same circumferential pull on any diameter we may wish to turn. Such a motor and the millennium are two things to be wished for, but neither of the two is at hand.

A series-wound motor seems to fulfill all the conditions, but it would race whenever the load is taken off. If we had a piece in the lathe which requires a perfectly even cut such a motor could be used, and the operator would use a controller and set it in a position for the proper speed, which speed would then be constant, as the load is constant; but if the cut were uneven, the operator would have to work his controller lever all the time to keep the lathe from running too slow when taking a heavy cut, or from racing and burning up his tool when the cut is light. But, worst of all, the greatest watchfulness of the operator would not help him when the tool is cutting metal on only part of the circumference and air the rest of the time. The lathe would gather up speed during its idle period, and the piece would run up

against the tool with such a velocity as to knock the tool, the lathe and everything else to splinters. I have been told that a certain lathe maker in this country once heard of the fine qualities of the series-wound motor and forthwith proceeded to build ten lathes with a series-wound motor incorporated in the headstock. This happened about three years ago. The ten lathes are still for sale, and any reliable party can have a motor-driven lathe, or a lathe without a motor, or a motor without a lathe cheap.

A shunt-wound motor is as steady as a Dutchman and almost equally inflexible. A well-made motor of this type does not vary its speed more than 10 per cent from full load to no load. It is a splendid motor to put in the headstock of a lathe in which you do not want to cut more than one kind of a piece and of one diameter. It also allows of speed control: that is to say, if your motor is designed to run at, say, 600 R. P. M., it is possible to make this motor run at practically any speed above or below 600 R. P. M. by means of controlling apparatus outside the motor. You put resistance in the shunt field circuit to make it run faster, or in the armature circuit to make it run slower. There are, however, reasons why this cannot be applied in a general way to machine tools. As everybody knows, the brushes of a motor are once set and then remain forever in that position. It is the position in which the motor is free from sparking. The present-day motors are all made with a field, which is relatively very strong as compared to the armature; that is to say, considering both field and armature as electro-magnets, the field is a very much stronger magnet than the armature. For this reason the greatest variations in current flowing through the armature have but little effect on the field; and the brushes, therefore, do not need to be shifted with the varying load. If we now insert resistance in the field circuit, and thus weaken the field, then the conditions mentioned above are changed. The field is not strong any more, as compared to the armature; the brushes ought to have been shifted, and fluctuations of the load. (that is, fluctuations of the armature current) require ever-changing positions of the brushes, which, of course, cannot be complied with, and the result will be sparking. Most present-day motors allow of a field regulation of from 20 to 30 per cent; that is, it is possible to run the motor at a speed which may be from 20 to 30 per cent higher than the rated speed by means of resistance in the field circuit. Greater variations will cause bad results. These 20 or 30 per cent may be split up in as many steps as one desires by splitting the resistance in a number of parts and furnishing the rheostat with a corresponding number of contact buttons. It must be remarked here that it is *possible* to get much greater speed regulations than 20 or 30 per cent, but not with an ordinary commercial motor. There are motors in existence which allow of a field regulation of 50, 75 or even 100 per cent; such motors, however, are very much larger than an ordinary motor of the same horse power, and, of course, correspondingly higher in price. I have in mind a 15 horse power motor which had a field regulation of 100 per cent, and which had a frame of a 50 horse power motor.

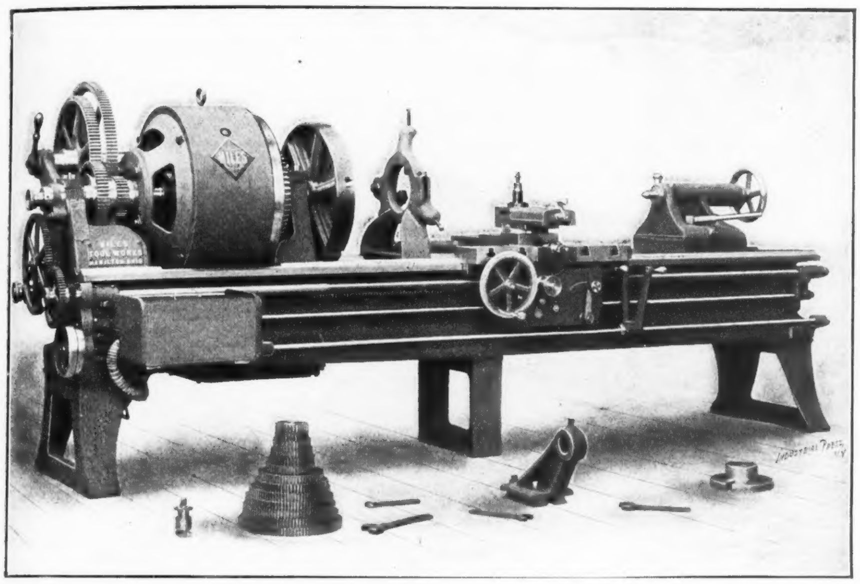


Fig. 3. Twenty-four inch Lathe with Variable Speed Motor.

Armature regulation is generally a very unsatisfactory way of varying the speed of a motor. Inserting resistance in the armature circuit lowers the speed of the motor, but it also makes the motor lose its most desirable quality—steadfastness of speed under varying loads. For instance: Suppose you have a motor which runs at 600 R. P. M. and takes 40 amperes at full load. This motor will run at practically the same speed, whether you use 40 or 4, or any other number of amperes. Now suppose you insert so much resistance in the armature circuit that the speed is reduced to 300 R. P. M.; when the motor takes 40 amperes then the speed will go up as soon as the load is diminished, or as soon as the motor takes any number of amperes less than 40. In other words, it behaves to a certain extent like a series-wound motor, and for this reason becomes unfit to drive a lathe.

Multiple Voltage System.

There is one way of changing the speed of a motor which has not so many disadvantages. It is a well-known fact that when the voltage of the line is changed the speed of the motor changes correspondingly, and practically, in right proportion to the voltage. For instance, a motor which would run 300 R. P. M. when supplied with 100 volts would run 600 R. P. M. when supplied with 220 volts. If it were possible, then, to quickly change the voltage of the line without disturbing other machines the problem of varying the speed of a motor would be solved. This, however, cannot be done, but the system known as "multiple voltage system" accomplishes the same result, and is based on the principle of varying the voltage. This system provides a number of voltages by using a number of dynamos, each with one or two commutators, and each supplying a different voltage. The Bullock Mfg. Co., of Cincinnati, O., is identified with this system, though of late other manufacturers of electrical machinery have also started on the same lines. The voltages supplied by the Bullock system are generally as follows: 60, 80, 110, 140, 190, 250, though other voltages can be furnished just as well. Four wires are needed, which are led to a controller that combines the wires in such a manner as to give the six voltages named above. The generators really furnish only three voltages, i. e., 60, 80, and 110. Fig. 2 shows the arrangement of wires as coming from the dynamos. It is, of course, immaterial whether three dynamos, each with one commutator, are used, or two dynamos, one of which has two commutators, while the other has only one. The three commutators of the three dynamos are represented by *a*, *b* and *c*. The wiring shows that it is possible to run *a* and *b*, or *b* and *c*, or *a*, *b* and *c* in series. This gives three voltages, besides the voltages which can be had by using each of the three dynamos singly. The controller is so arranged that two of the four wires are led to the motor—*a* and *b*, 60 volts; or *b* and *c*, 80 volts; or *c* and *d*, 110 volts; or *a* and *c*, 140 volts; or *b* and *d*, 190 volts; or *a* and *d*, 250 volts. Two hundred and fifty volts are used for the field. As the voltage for the field is constant, and the armature voltage is variable, it follows that the motor does not exactly behave as a shunt-wound motor, or, in other words, its speed is not constant under varying loads. The variations in speed are, however, so small as to offer no practical objection for machine tool work.

It is possible to extend the range of speeds due to the different voltages by field regulation. Adding 30 per cent to the range of speeds already obtained this range becomes 60 to 333, or more than 5½ to 1. This field regulation serves

another purpose besides extending the range of speeds; it allows the operator to obtain practically any speeds between the steps due to the different voltages. Applied to the lathe this means that the lathe hand can get the proper speed for any diameter, or change his speed gradually when facing.

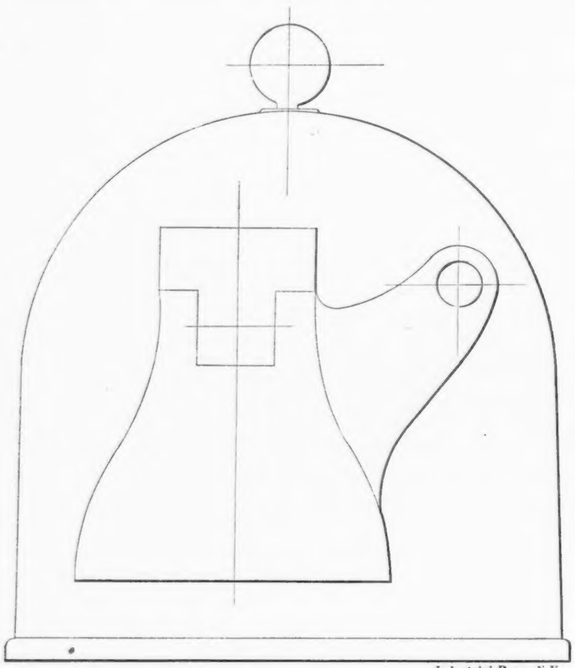


Fig 4. Outline of Variable Speed Motor and Lathe Headstock.

Fig. 3 shows a 24-inch Niles lathe driven by a Bullock variable-speed motor (multiple voltage). In this case the motor is built into the headstock, the outside of the motor being turned and the headstock being bored out as a seat for the motor. The controller can be seen at the left-hand end of the bed. A splined rod, extending along the front of the lathe and operated by a lever which moves with the carriage, serves to operate the controller. The motor is reversible. It will be seen that there are two sliding gears on the back gear shaft which extend the range of speeds obtained by the motor. An arrangement of this kind is neat and handy and very economical, as the operator need not hesitate to change his speed whenever he thinks it advisable to do so. Like all other good things, however, this arrangement has its drawbacks also. In the first place, this method of driving a lathe cannot be applied unless the shop is supplied with more than one voltage. In the second place, a motor like the one shown here is not a piece of standard apparatus, so that repairs cannot easily be had. The first objection is not quite so formidable as it appears at first glance. Any shop which possesses an electrical generating plant can arrange for the multiple-voltage system by installing what is known as a rotary converter, or booster, or balancer. This apparatus splits the voltage, or rather uses the voltage at hand, and produces the voltages required. It might not pay to install such a converter for only one tool, but where a number of tools have to be driven it certainly is cheaper to buy a converter than to throw out the old dynamos and install new ones. Such a rotary converter does not always need to have a capacity equal to the horse power of all the tools to be driven, as it is natural that at least some of the tools will be using the original shop voltage. A rotary converter is also to be recommended where a large proportion of the power is used for lighting, or for cranes, and only a small portion for driving the machine tools. Some makers of electrical machinery use only two voltages; for instance, 110 and 220, and fill the gap between the two speeds by field regulation. This necessarily makes the motor excessively large.

Fig. 4 shows an outline of a motor which was to drive a 24-inch lathe, the headstock of which is shown in the same sketch. Both outlines are drawn to the same scale. The cut shows clearly one of the difficulties the machine tool designer has to deal with when he attempts to connect a variable-speed motor to a lathe. The size of a motor of given horse power is a quantity which varies between very wide limits. It is no exaggeration to say that one motor maker makes every dimension 50 per cent larger than another, and, therefore, while it is possible to use some kinds of motors for direct drive, it is entirely unpractical to use a motor of some other maker. I am not writing advertisements for any one electrical concern just now, nor criticism of any other one, and so I leave the names of the successful as well as of the unsuccessful motor makers unwritten. It seems rather strange to the outsider that there should be such a difference, and I am not prepared to explain the fact; I know, however, that the fact exists and that this is one of the reasons why

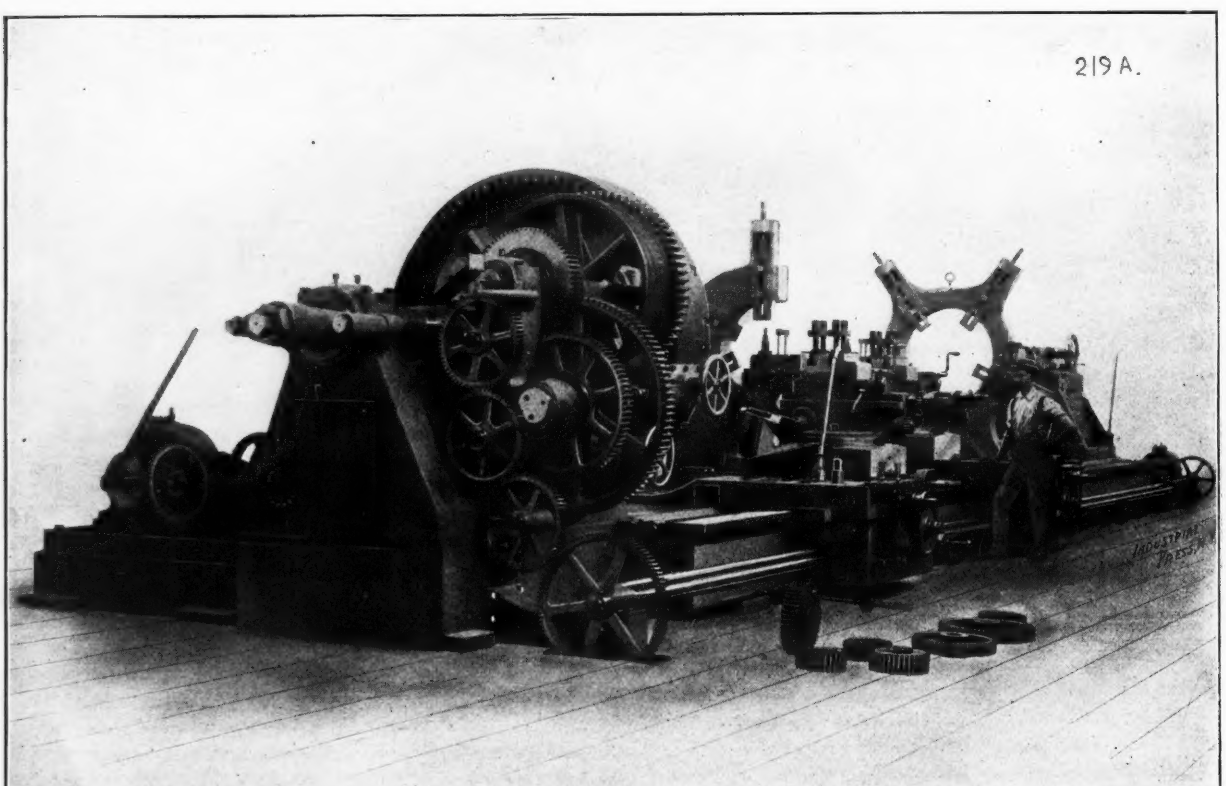


Fig. 5. Ninety-inch Crankshaft Lathe with Constant Speed Motor with Speed Changes by Means of Gears.

it is impossible to standardize electric drives for machine tools.

Before I mention any other mode of driving a lathe by means of a motor I want to say a few words about the results one can obtain with multiple voltage. As the torque of a multiple-voltage motor is constant it follows that the horse power increases with the speed, and that the term of, say, 10 horse power has no meaning unless one states at which speed the motor is supposed to develop 10 horse power. It also follows that the same torque is always available, whatever diameter one wants to turn; and that, therefore, the available pressure at the tool point becomes greater the smaller the diameter. Suppose, for instance, you have a motor which runs from 240 to 1,200 R. P. M., and that this motor develops 2 horse power at the lowest speed. Suppose you use this motor on a 24-inch lathe, and that you turn up a piece 24 inches in diameter. What will be the pressure at the point of the tool under these conditions? As 1 horse power equals 33,000 foot-pounds, 2 horse power gives 66,000 foot-pounds. Suppose you are cutting at a speed of 20 feet a minute; then the pressure at the point of the tool will be $66,000 \div 20 = 3,300$ pounds. Now, when you want to turn up a piece 12 inches in diameter, you must run your lathe twice as fast, and, therefore, the motor must run 480 R. P. M. The motor develops at that speed 4 horse power, or 132,000 foot-pounds; and, as the cutting speed is again 20 feet, the pressure at the tool point is now $132,000 \div 20 = 6,600$ pounds. The fact that the pressure becomes greater when the diameter becomes less is of no use, except in so far as it serves to overcome the greater friction in the lathe, due to the higher speed. In other words, the motor is sometimes just large enough, but more often much larger than you want it. There is, however, another side to this story. It is sometimes advisable to run the lathe at higher speeds than it is designed for. For instance, when using some self-hardening steel for tools, which allows to cut at much higher speeds—the Taylor-White steel, for instance, for cutting steel. If you try to do this on the ordinary lathe, by shifting the belt one or two steps lower down on the cone, or by throwing the back gear out, you will find that the lathe has the proper speed, it is true, but not power enough to pull the cut. The only thing left, then, is to speed up the countershaft. This, however, is a nuisance, to put it mildly, and, besides, gives such a high speed to pulleys and cones that it is only practical within very narrow limits. It is an entirely different matter, however, with a lathe driven by a multiple-voltage motor. Whether you cut your piece at a cutting speed of 20, 30, 60, or 100 feet you always have the same torque, and, therefore, as long as you do not change the diameter, the same pressure at the point of the tool.

Fig. 1 shows a view of a 63-inch lathe which has four carriages—two in front and two in the rear—built by the Niles Tool Works Co., and which is driven by a 15 horse power motor geared to a cone. This cone, with the motor, is placed on a carriage or slide which allows of slacking the belt when the belt has to be shifted. It will be noticed in this machine that the cone is at right angles to the axis of the lathe. This was made necessary by the fact that a worm and wormwheel were introduced in the drive.

In Fig. 5 is an illustration of a 90-inch crankshaft finishing lathe of extra heavy design. The motor used for this machine was of constant speed, and the necessary speed variations were provided for by means of change gears, that can be seen at the extreme left of Fig. 5. A pulley, visible in the headstock, was keyed to the second change gear shaft, which drove the large pulley, and there is a second motor at the extreme right, which was used for the quick traverse of the carriage. Although this does not properly belong to a description of electric drives, it may perhaps be remarked here that the lathe had two carriages, each of which was entirely independent of the other; that is, each one could feed in either direction, or stand still, or traverse quickly in either direction, or have a fine or coarse feed, no matter what the other carriage was doing at the same time. It may further be noticed that all movements of the carriage, as well as of the compound rest, can be controlled by a man standing on the carriage, as is necessary with a lathe of so large a swing.

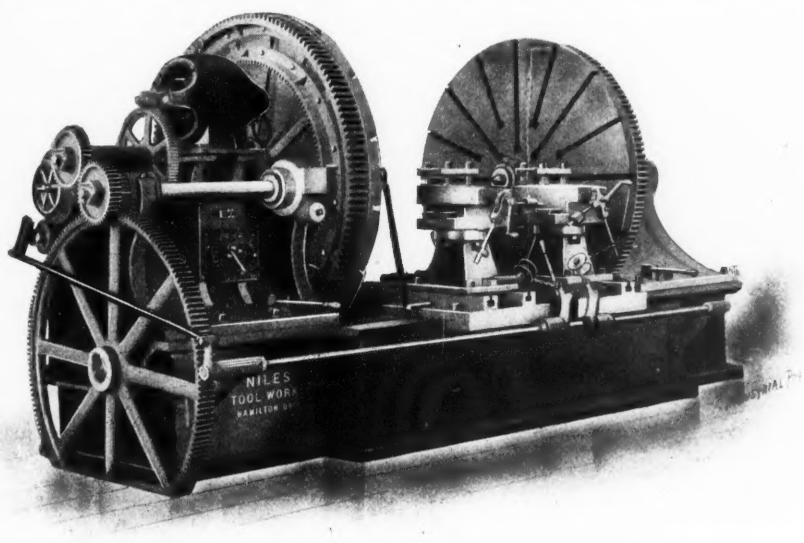


Fig. 6. Driving Wheel Lathe with Constant Speed Motor.

Fig. 6 illustrates a driving wheel lathe of heavy pattern which is driven by a constant-speed motor, the various speeds being obtained by means of change gears at the end of the headstock. As one of the objects of the electric drive of machine tools is to do away with all overhead works it was necessary in this lathe to change the usual feed arrangement, which, as is well known, is by means of an overhead rocker shaft in lathes of this type. All the lathes shown in the accompanying illustrations are built by the Niles Tool Works Co.

* * *

SUGGESTIONS TO ENGINE BUYERS.

A simple horizontal throttling slide-valve engine is to be recommended for low first cost, cheap fuel, small floor space, small operating skill required, medium or high speed.

A horizontal throttling compound slide-valve engine is to be recommended for medium first cost, fair economy, medium floor space, for pressures of 90 pounds and upward, small ability for operating, medium or high speed.

A simple Corliss is to be recommended for medium first cost, good economy, slow speed, long but narrow floor space, 70 to 125 pounds pressure. Requires fair operating ability.

A compound Corliss non-condensing engine at high first cost, gives good economy with steady loads, and is to be recommended for large floor space, pressures of from 110 to 160 pounds, first-class ability for operating, slow speed.

A compound Corliss condensing engine, at high first cost, is to be recommended for the best attainable economy, with boiler pressures of from 90 to 160 pounds, for first-class operating ability, slow speed and plenty of room.—From Lane & Bodley's Catalogue.

* * *

HE WAS A MACHINIST.

A very stylish lady entered a crowded street car in Cincinnati one evening at 9 P. M. A plain but clean workingman immediately got up and offered her his seat. He discovered, however, that she was not lady enough to thank him for the attention, but took the seat as if it were hers by right. Thereupon he asked her to let him see if he had left his handkerchief in the seat, and when she rose, he sat down again. She got off at the next stop, and some were heard to exclaim that "it served her right." The man wore a twist drill on his chain.

H. L. C.

MODERN ENGINE BUILDING.

NOTES TAKEN AT THE SHOPS OF THE WESTINGHOUSE MACHINE COMPANY.

Geographically, and by lapse of years, it is a far cry from the old engine shop of James Watt, at Soho, England, to a modern engine-building plant like that of the Westinghouse Machine Co., at East Pittsburg, Pa. Yet probably as relatively great is the gulf separating the primitive engines and tools used for their production in the time of Watt from the modern engines and machine tools and appliances to be seen in the Westinghouse shops to-day. The concrete result of a century of continued improvement in steam engine design, in machine tool development and in shop practice is embodied in the manufacture of the best modern steam engines.

The shops of the Westinghouse Machine Co., built in 1895, are located on the main line of the Pennsylvania R. R., in the center of the iron and steel industry of the United States. In the immediate vicinity are immense deposits of bituminous coal, from which coke is made in great quantities. Natural gas is also found in near-by fields and has been largely used in manufacturing, although the decreasing gas pressure has led to its abandonment in general. In many individual instances, however, it is still used. Gas wells are located on the Westinghouse property, and the gas is used for the operation of gas engines and for other purposes.

The plan of the main shop is that of two central bays, 1,200 feet long by 230 feet wide, served by traveling cranes, with galleries at the sides and in the center between the bays. The scheme for power distribution is that of electrical transmission from one central station. Alternating-current polyphase motors are used in all cases, including those for the traveling cranes. The general plan for the smaller machines is to group them and to drive them from a motor-driven line shaft. A few of the larger, however, are driven by individual motors. The sections of line shaft are generally driven by motors located on the floor for convenience in attention, power being transmitted to the line shaft by belting. The plan of grouping of machines like planers is to arrange them so as to get as nearly as possible a constant load. Thus in the planer department there are six planers driven by one motor. They range in size from 48 inches for the smallest to a Pond planer which takes in 14 feet between the housings and 10 feet 7 inches under the cross-rail.

The boiler equipment in the power house is Babcock & Wilcox. The boiler furnaces are fed by Roney stokers. The engine room contains five compound steam engines aggregating 1,000 horse power and seven gas engines aggregating 915 horse power. Most of these engines are direct-connected to electric generators, and all the apparatus is of the Westinghouse type. The power equipment is housed in the same building with the blacksmith shop and the warehouse. The space between this building and the machine shop is taken up by a railway switch and a 50-ton Gantry crane. This crane serves the entire space between the two buildings and runs on rails laid on ties the same as the railway tracks.

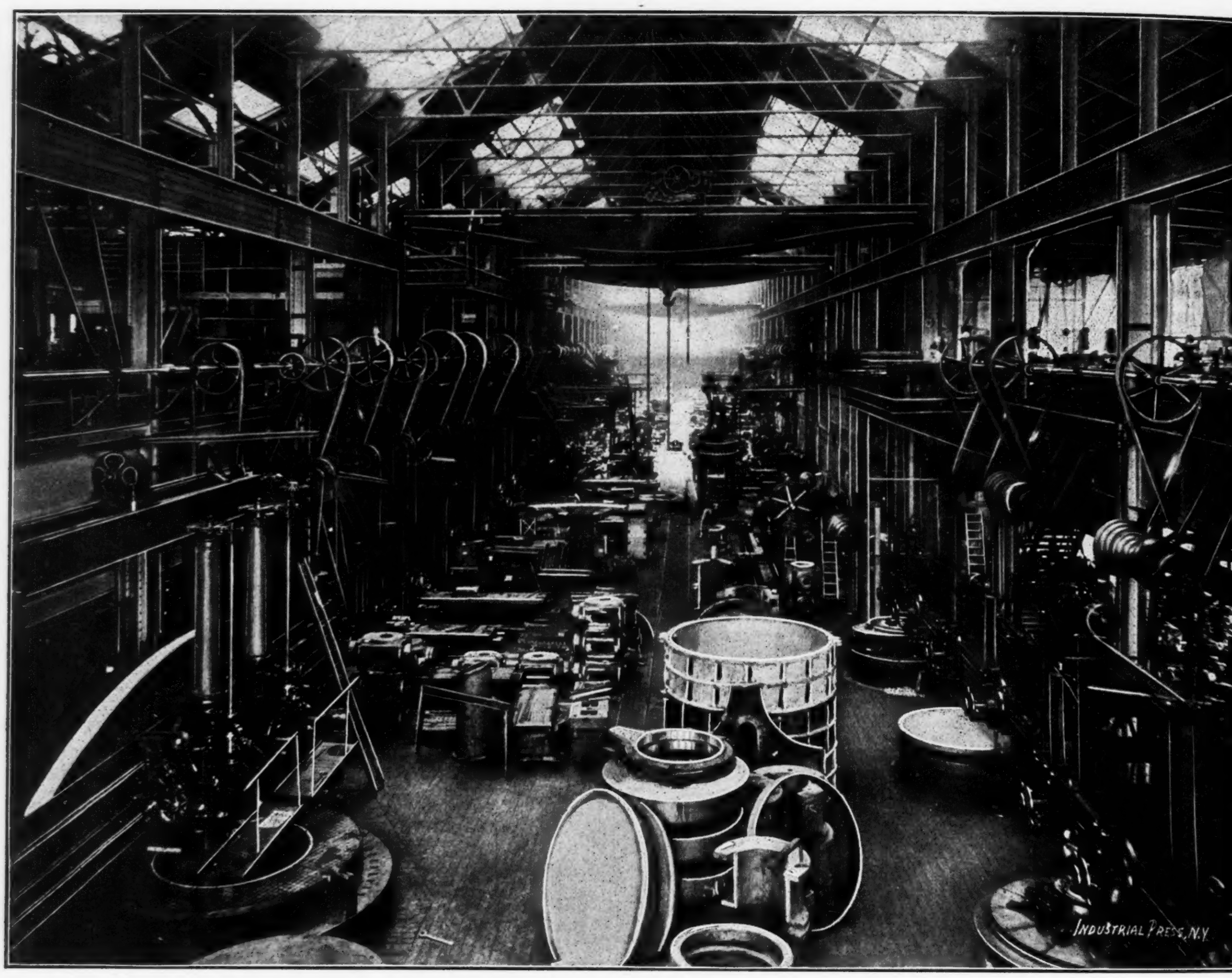


Fig. 1. North Bay of Machine Shop looking towards the Foundry.

The foundry is a continuation of the north bay of the machine shop, the space between it and the south bay of the machine shop being utilized as pattern storage. The sand, coke, coal and iron are run in beside the foundry on a railway switch located directly beneath the storage bins at the side of the building. The foundry is served by electric traveling cranes supplemented by smaller wall, post and jib cranes. Labor-saving devices and appliances such as power sand sifters, etc., are quite generally employed. The castings, uniformly made in green sand with green sand cores,

are remarkable for their smoothness, freedom from blow holes and truth to pattern, a result due, in great measure, to the rigid inspection which all materials are required to pass. Analyses are made in the laboratory to determine the chemical qualities of the material entering into every heat. Standard test bars are made and broken, and records made of each test.

The pattern shop lies adjacent to the foundry. At the opposite end from the foundry and on the same side of the machine shop are the offices, separated from the machine shop by a division wall pierced by many windows, as indicated in Fig. 5. This view shows the division wall back of the large lathe. The executive offices are on the first floor, and the drafting rooms on the second and third floors. There is also on the third floor a lunch room where the foremen, draftsmen, clerks and officers eat their mid-day meal.

Both steam and gas engines are built, the former in sizes ranging from 5 to 6,000 horse power, and the latter in various sizes from 10 to 650 horse power. The Westinghouse steam engine is too widely known to require description. The gas engine is built on the same general lines, and the same methods of manufacture are followed in the construction of each type. All work is made strictly interchangeable. The shop equipment comprises a complete assortment of jigs, fixtures and gages such as are generally used in interchangeable manufacture. This system has been in vogue with the company for so long a time that it has entirely lost all novelty and is regarded as a matter of course. Not less complete is the system of inspection. The inspectors are clothed with authority, which makes their decisions not subject to reversal, and consequently they are held responsible for results. The inspection system extends to making the measurements and passing on the allowances for press and shrink fits. Their experience and judgment in this difficult feature of machine construction is assisted by what is probably one of the most complete records of press and shrink fits in the country. To facilitate the measurement of large shafts special micrometer calipers have been designed and made which were illustrated and described in the July, 1901, issue by Mr. J. B. Thomas. These calipers are of such a form as to make deflection a minimum, and all measurements and comparisons to the standard length gages are made with the calipers in a vertical position. A special fixture supports the weights while measurements are taken, so that the influence of having to support the caliper in the hands is removed, which enables all the inspector's attention to be directed to getting the delicate touch necessary to accurate measurement.

The building of the steam and gas engines on the interchangeable plan and the general policy of the company, bring nearly all the repair work their way. Instead of charging an exorbitant price for repair parts, these are furnished to customers on the same equitable cost basis as the complete engines. Consequently it is usually cheaper to buy repair parts from the company than to have them made in local shops. Since most of the repair parts are made and sold by the company they are enabled to keep a complete record of the endurance of almost all engines sold. Those repair parts which have been much called for have speedily become the subject of scrutiny as to design and material, and, where possible, steps have been taken to make them more durable. Some surprising facts are disclosed by a study of the records of engines made and sold years ago. Many that are known to have been practically in constant use, and for which all the repair parts have been furnished, show a trifling repair bill.

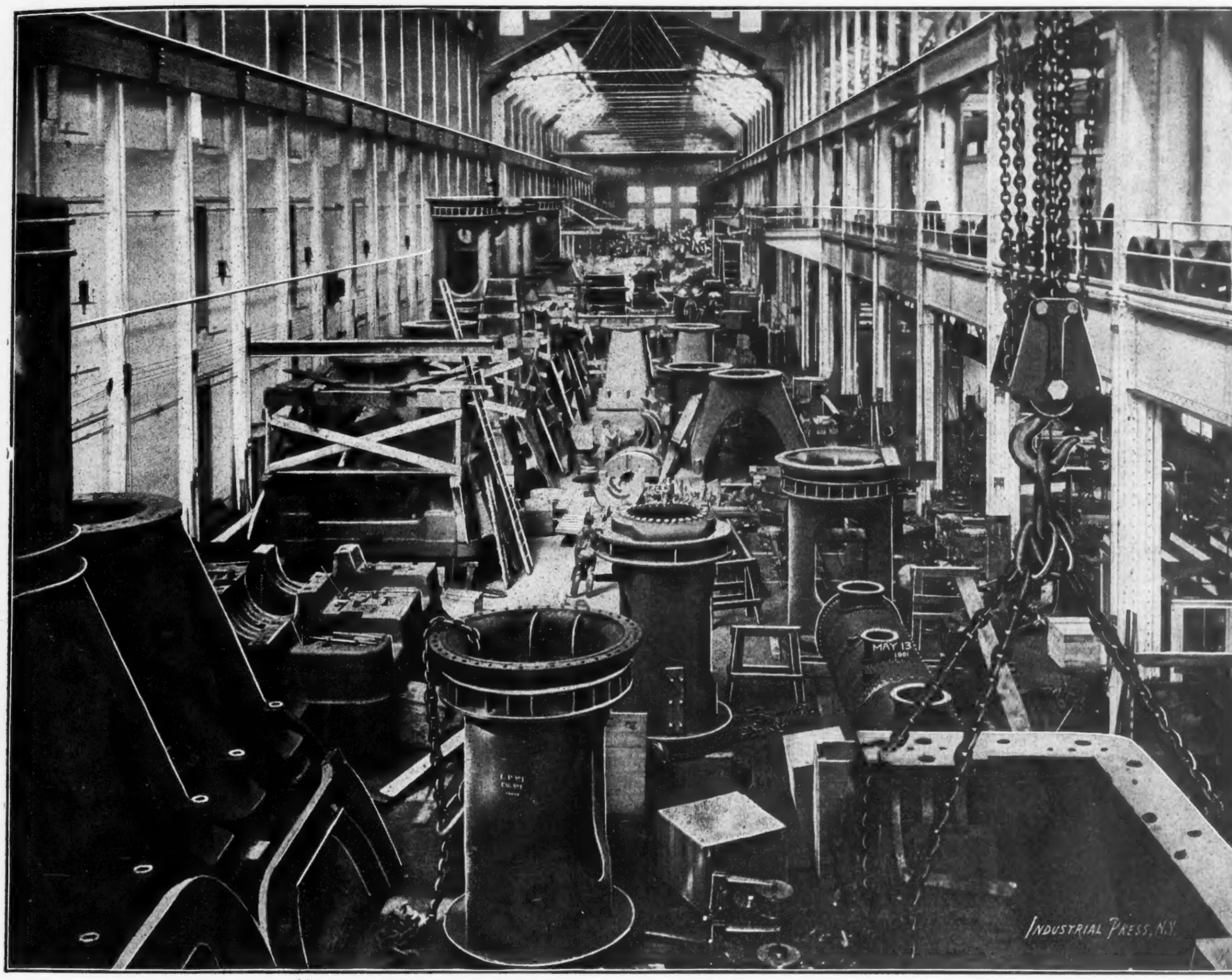
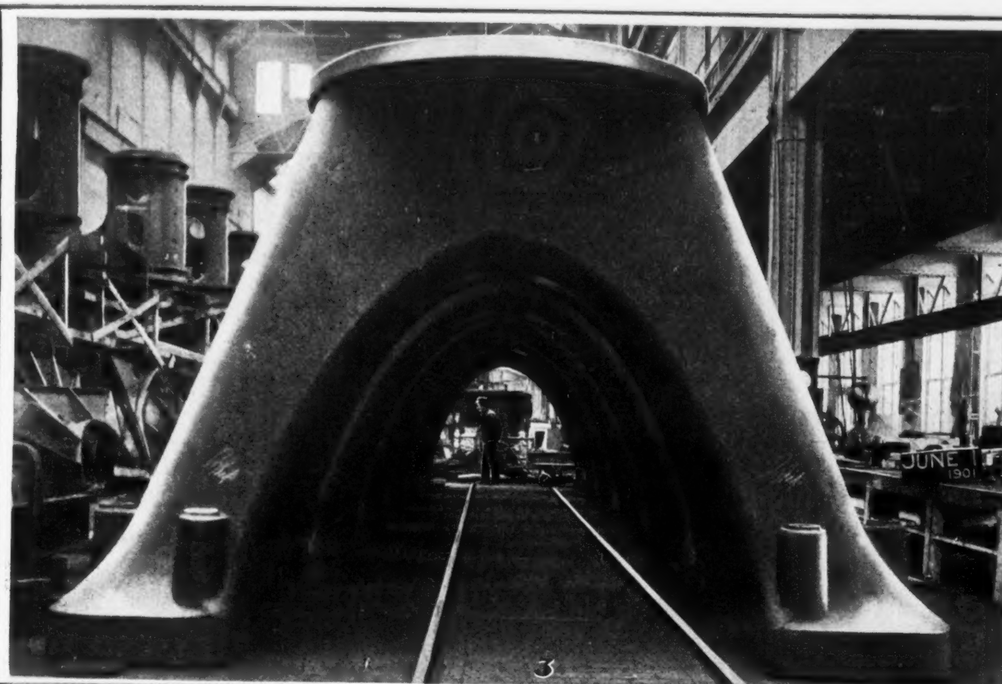
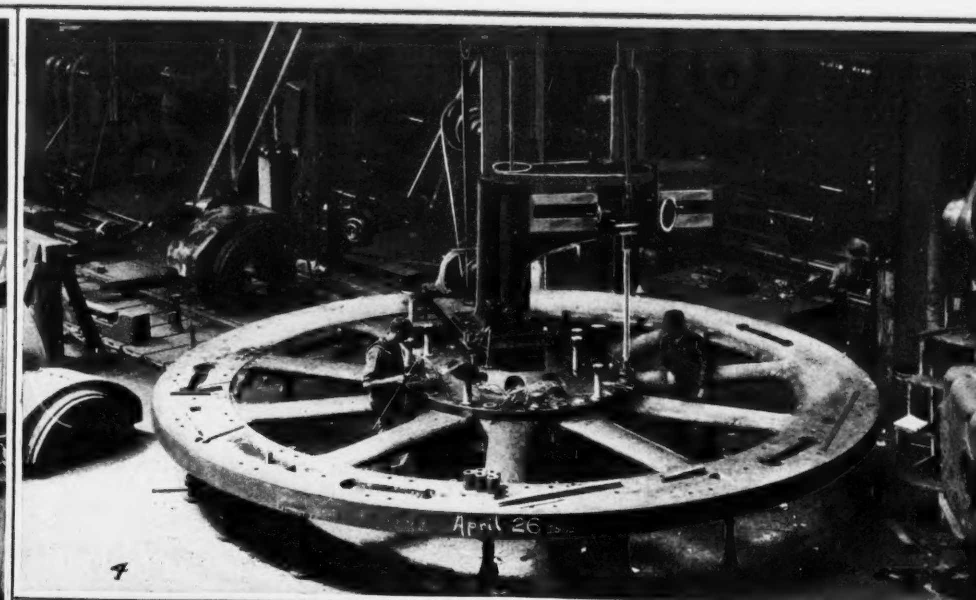
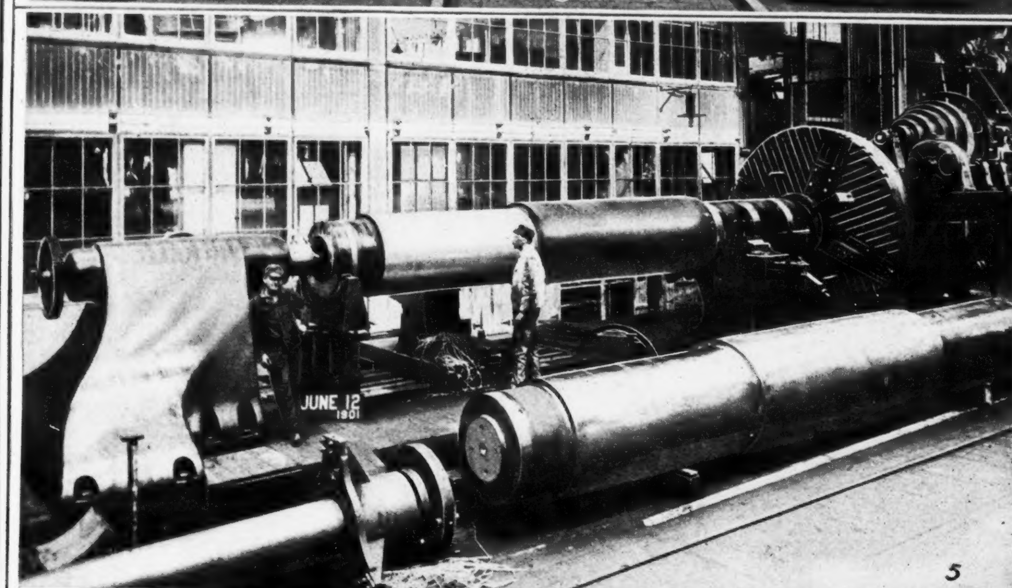


Fig. 2. Erection Shop, looking toward the Testing Department. Traveling Crane of this Section has Clearance of Sixty Feet Beneath the Hook.

The greater portion of all repair parts needed for the many thousand Westinghouse engines are supplied by the company and hence this part of their business is not unimportant. It has been systematized so that the furnishing of a repair part is accomplished at a minimum of expense. The crankshafts for the regular line of steam engines are







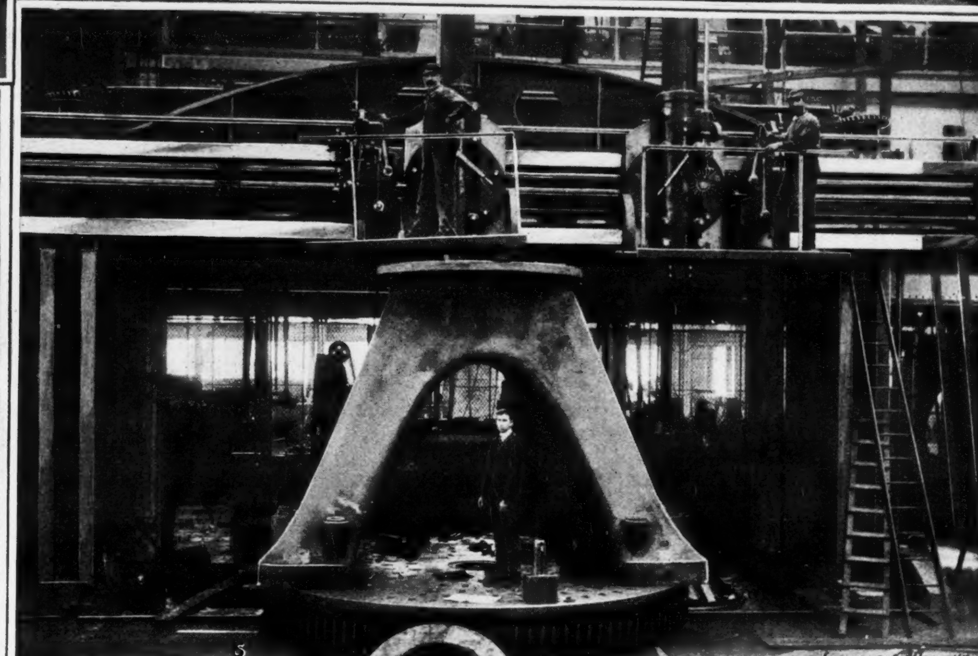


Fig. 3. Row of Housings for 43 1-2 inch and 75 1-2 inch and 75 1-2 x 60 inch engines for the New York Edison Co.

Fig. 5. Turning Shafts for 4,500 H. P. Engines for Edison Electric Illuminating Co. of Brooklyn. Length, 28 feet; maximum diameter, 39 inches; weight, 36 tons; Shaft hollow; diameter of hole, 16 inches.

Fig. 4. Building a Twenty-three Foot Flywheel. Five Circular Plates are Riveted on each side of the Rim. Rim and Plates held together by Shrunk-in I-links.

Fig. 6. Facing Off top of Housing in Sellers twenty-eight foot Boring Mill.

forged under heavy steam hammers, ranging in size from ten tons down. The shafts are forged out as indicated at *A* in Fig. 14, in which shape they are taken to the machine shop. The heavy stock between the cranks is removed by drilling and slotting as shown at *B*. After this the machine operations are confined to the lathe. The three-throw cranks required for the three-cylinder gas engines are built up of three forgings. The end sections are forged each with one crank the same as indicated in the case of the two-throw crank. The middle crank is a separate forging comprising the two crank cheeks and crank pin.

The pistons of the standard engines are fitted with snap rings which are most carefully made. They are turned and cut off from the casting in about the ordinary manner. After being cut off they are cut apart and then the sides are ground while the ring is compressed to the same degree as it will be when in the cylinder. In this manner it is possible to get a smooth surface and to have all parts of a ring of uniform thickness, which would not be the case if the ring were ground in its expanded form or when uncut. The grinding is done in grinding machines which have been rigged up for the purpose and fitted with magnetic chucks for holding the rings in position. The rings being held in position by magnetic attraction, no clamping is necessary. The grinding is rapidly done in a most accurate manner.

All engines except the largest are subjected to a running test before they are shipped. At the time of the writer's visit both steam and gas engines were being tested of varying sizes from the smallest of 5 horse power up to steam engines of 500 horse power. One of the latter size being tested was a vertical compound engine for the new Union Station of the Pennsylvania R. R. system at Pittsburg, Pa. The consumption of steam by the testing department is, of course, considerable. Often there will be a dozen or more engines of various sizes running at full load while restrained by Prony brakes. Large surface condensers are provided near the testing block with weighing tanks beneath, so that the matter of determining water consumption is readily done with a minimum of labor. A system of telescopic pipe connections is provided for readily connecting up the steam and exhaust pipes of the engines to be tested.

The present era of large central station building has led to the building of steam engines of enormous proportions. The Westinghouse Machine Co. are now engaged in the construction of eight superheated steam engines of 6,000 horse power each for the new power plant of the New York Edison Co., at 38th St. and East River, New York. They are also engaged on eight 5,000 horse power engines for the Third Avenue R. R. Co., New York, and on two 4,500 horse power engines for the Boston Elevated Railway. The engines recently built for the Edison Electric Illuminating Co., of Brooklyn, were rated at 5,000 horse power. All these engines are of the vertical compound type, direct-connected to electric generators. The accompanying illustrations show some interesting views taken in the works during the progress of work on these immense prime movers. Photographs are taken at frequent intervals, and thus constitute a faithful record of the progress of work. Such a record is most convenient for reference, as it tells so much at a glance that could be sifted from written records only at the expense of much time and labor.

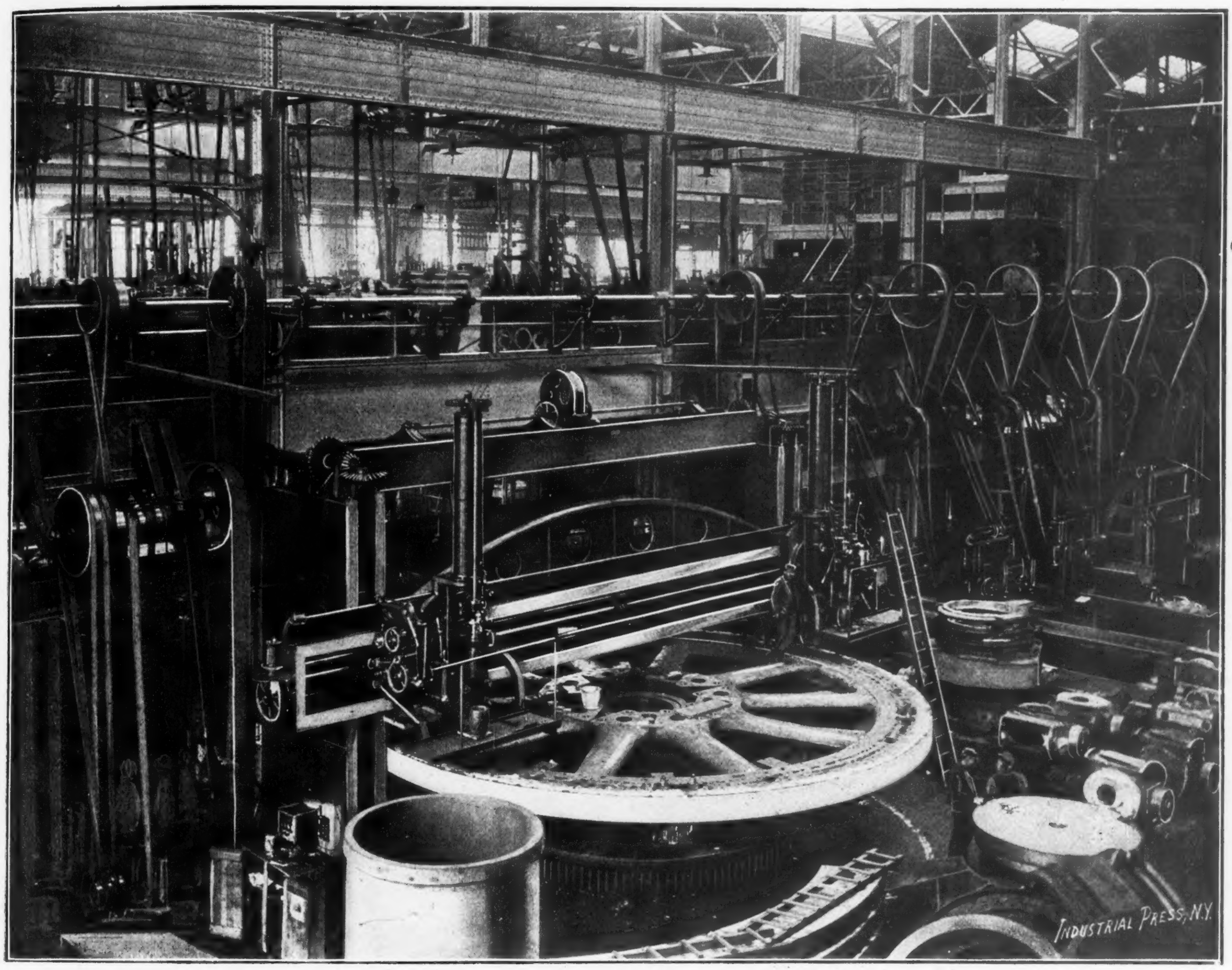
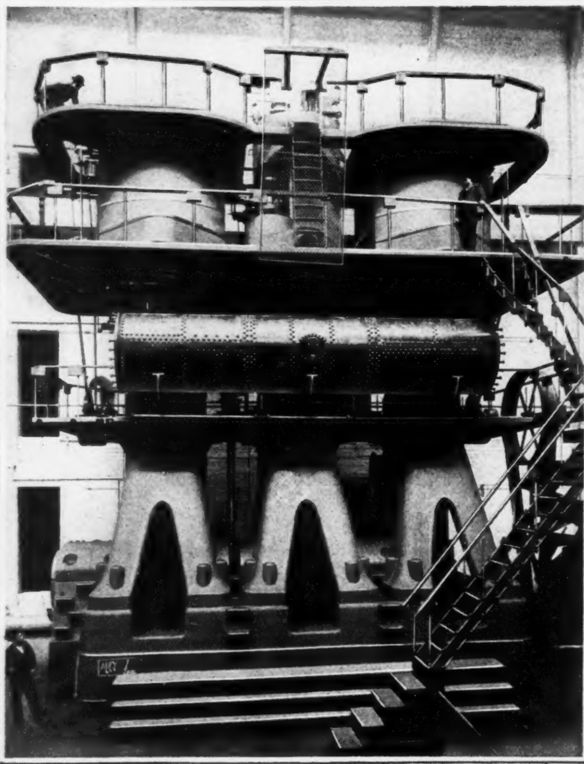
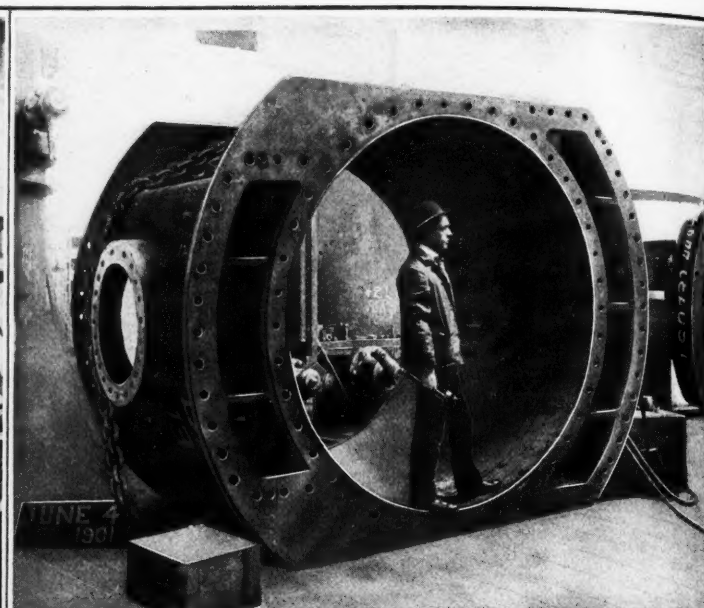
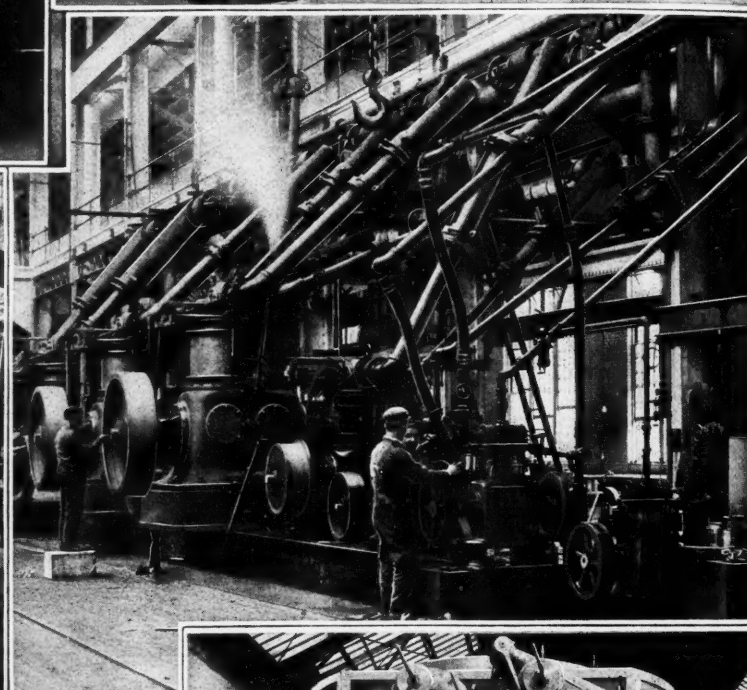


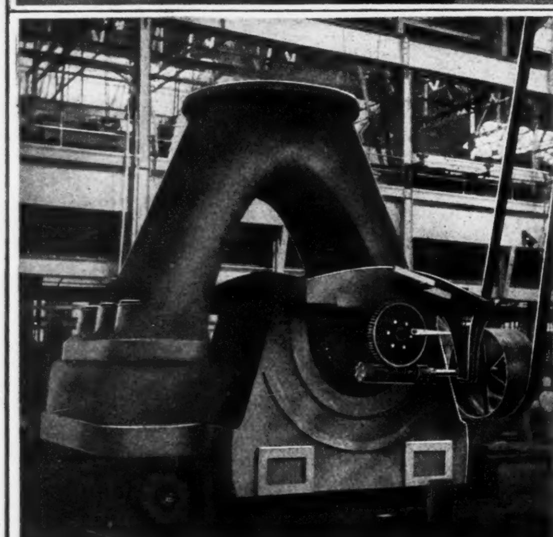
Fig. 7. Turning Twenty-eight Foot Flywheel on Sellers Boring Mill for 4500 H. P. Engines.

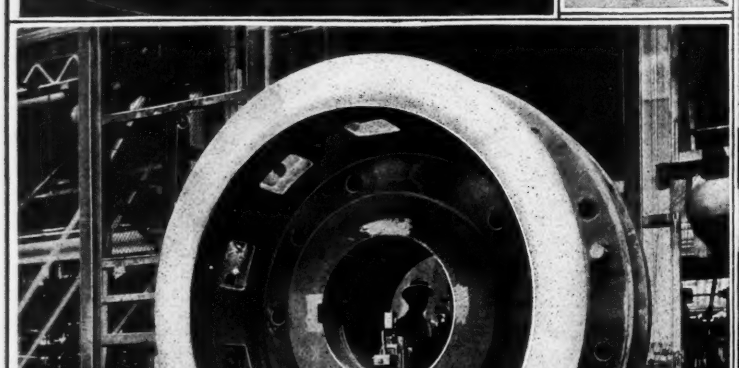
Fig. 1 is a general view of the north bay of the shop looking toward the foundry. At this end of the shop are located some heavy machine tools. At the left in the foreground is a Sellers 28-foot boring mill. This machine, also shown in Figs. 6 and 7, is of slightly different design from the one in the works of the Westinghouse Electric & Mfg. Co., illustrated in the October issue. At this end of the shop (but not shown) is a Pond rotary planer having two cutter heads, one of which is adjustable on the table relative to the other.











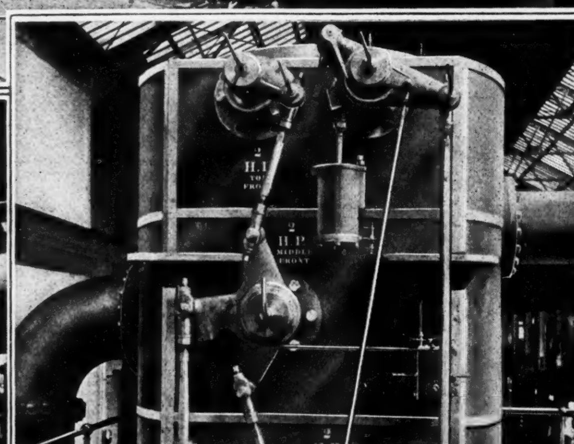


Fig. 8. Superheated Steam Engine of 6000 H. P. for New York Edison Company.

Fig. 9. View showing comparative size of Low-pressure Cylinder for Boston Elevated 5000 H.P. Engines and of a Man.

Fig. 10. Special Boring Bar Boring Spherical Seat in Pillow Block.

Fig. 11. Testing Department.

Fig. 12. Cutting Keyseats in Hub of Large Flywheel, using a Morton Draw-out Shaper,

Fig. 13. Valve Gear for High-pressure Cylinder for 4500 H. P. Engine.

The table or floorplate is about 20 feet square. This machine is principally used for milling off the ends of flywheel segments. Near this tool is a boring mill used for boring cylinders. The practice is to bore the cylinders in a vertical position on the boring mill and revolve the cylinder, which is contrary to the more usual practice of revolving the boring bar in the cylinder while stationary. Further up this aisle is a Bement, Miles & Co. 125-inch lathe, shown in Fig. 5 with a shaft in the lathe for one of the engines for the Edison Electric Illuminating Co., Brooklyn, N. Y. This shaft weighs 36 tons finished, and is about 28 feet long. It is hollow, having a 16-inch hole throughout. Its maximum diameter is 39 inches. Such large and heavy shafts are not permitted to bear on the centers of the lathe with their full weight, as this would cause excessive wear of both the centers and the plugs in the shaft. A rest is provided near each end which carries nearly all the weight and so relieves the centers. The shaft is carried on hardened steel centers secured in cast-iron plugs forced into the hole. All the shafts are turned and finished with great care. After having been turned they are ground by an emery wheel attachment mounted on the tool carriage and driven by an electric motor. The crank disks for these shafts are bored and scraped to plug gages which are made with the proper force fit allowance, as prescribed by the inspection department.

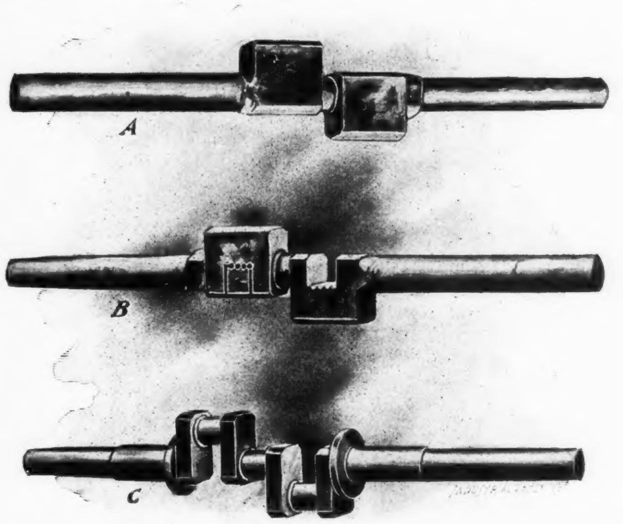


Fig. 14. Method of Machining Crankshafts.

A view of the erection shop is given in Fig. 2, which shows the erection of some of the large engines for the New York Edison Co. The traveling crane for this department has a clearance of 60 feet beneath the hook. The type of flywheel used on the large engines recently built is shown in Figs. 4 and 7. The flywheel shown in Fig. 4 is 23 feet in diameter and is made of five sections, the rim of each having an angular length of 72 degrees, a depth of 30 inches, and a thickness of 9 inches. The ends of the sections are held together by I-links shrunk into place, and each of the two arms of each section is held to the hub by three bolts. On each side of the flywheel rim are riveted five segmental plates, each ¾ inch thick, which makes the total width of the rim 16½ inches. The side sections are also bound together by "shrunk in" I-links, and are so arranged that joints are broken so that no two joints come opposite. This wheel is designed for a peripheral speed of more than one mile a minute (5,419 feet). The flywheel shown in Fig. 7 is substantially of the same design but is larger, being 28 feet in diameter. The plan of taking the tools to the work is illustrated in the case of the flywheel in Fig. 4. A radial drill is clamped on the wheel and employed for drilling, reaming and boring. Another portable tool is that shown in Fig. 10. The illustration shows a special boring bar boring a spherical seat for the shaft bearings, which makes them self-adjusting. The boring bar carries a radial arm on which is mounted the cutting tool. The tool swings in the arc of a circle and thus generates a spherical surface as the bar turns. The bar is mounted on a large flat casting which is set on top of the pillow block, as shown. In other cases the cylindrical seats for bearings are bored by an ordinary boring bar having a traveling head.

Another noticeable tool is the Morton draw-cut shaper shown cutting a keyseat in the flywheel hub of a 6,000 horse power engine. A feature about this hub is that it has a four-step bearing on the shaft. The four successive diameters are plainly visible in the bore of the hub. The practical advantage of this construction is that the hub has to be pressed onto the shaft only one-fourth as far as would be necessary for a plain cylindrical fit. Not having to be pressed so far the surfaces are not so likely to be abraded. The experience of some European builders seems to indicate that such a fit has considerably more holding power for the same degree of applied pressure than the plain cylindrical fit. Fig. 8 shows one of these engines as erected in the shop. The practice is to assemble these large engines complete, with the exception of the flywheel and shaft. In place of the flywheel shaft a dummy shaft is mounted concentric in the shaft bearings, and on it are mounted the eccentrics. The valve motion is erected complete, and driven from the dummy shaft by an electric motor. In this way it is possible to make all adjustments of the valve gear and governor so that when the engine is finally erected it is ready for work. In the case of the engine shown in Fig. 8 the eccentrics are carried on a lay shaft about on a level with the first platform. This lay shaft is driven from the main shaft by spiral gears. The aim in this design is to do away with the necessity for the enormous eccentrics that would be required on the main shaft. Eccentrics of such large size absorb a great deal of power because of their large peripheries. During the shop erecting the lay shaft is driven by a motor and the valve motion adjusted and worn to working conditions.

The valves for the high-pressure cylinder of these engines are of the double beat poppet type. There are two admission and two exhaust valves. The valves for the low-pressure cylinders are of the Corliss type and are placed in the top and bottom cylinder heads. This position makes possible a great reduction in port length and a consequent reduction in the clearance volume. The cylinder shown in Fig. 9, intended for the Boston Elevated Railway Co., is of the same construction. The cored opening at one side of the bore is for the steam inlet, and that on the opposite side for the exhaust.

* * *

ARE WE APPROACHING SOCIALISM?

The United States is operating a railroad of its own, and does not make a cent out of it from one year's end to the other. Only a few miles from New York, on the Sandy Hook peninsula, is a six-mile steam railroad with Fort Hancock as one terminal and Highland Beach as the other. This road, while limited in its rolling stock to one locomotive, one combination baggage and passenger car, and several freight cars, is in touch with the whole country, as it connects at Highland Beach with the Central Railroad of New Jersey. Large operations in the line of ordnance tests are secretly conducted at the Sandy Hook proving grounds, by the Ordnance Department at Sandy Hook, and it is the transportation of this ordnance, together with ammunition and supplies, that furnishes the bulk of business of this railroad. The passenger traffic is small, as it is limited to those having passes issued by the military authorities of the United States. Aside from the inscription, "Sandy Hook Proving Grounds," which appears on the cars and locomotives, there is nothing about the train to suggest the ownership of the road. Nevertheless, it is Uncle Sam's own railroad, with an artillery sergeant as conductor and a competent traffic manager, Colonel J. B. Burbank, who is at present in command at Fort Hancock.—*American Engineer.*

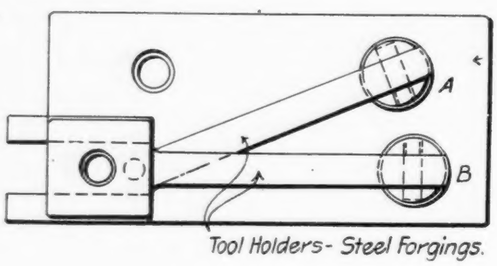
* * *

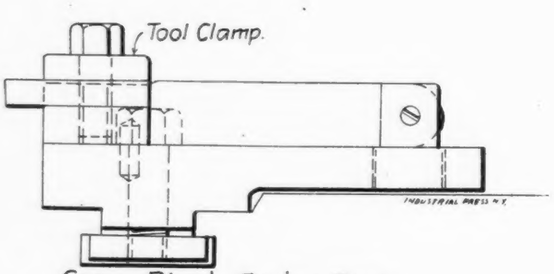
A bright-looking young fellow with a bundle was about to go to work in a gloomy out-of-date looking shop, filled with a lot of old machinery. After looking around a bit, he decided to go out again and as he turned, the boss stepped up to him and inquired if "he was trying to show his contempt for the shop." "No," the fellow answered, "I was trying to conceal it." H. C. L.

TURRET TOOLS.

USED FOR MACHINING GEAR BLANKS IN THE TURRET LATHE.

The National Machine Tool Co., Cincinnati, O., have recently placed on the market a variable speed countershaft in which the speed changes are obtained through the use of two nests or cones of gears. The gears have to be made in large numbers, and of course are of varying diameters to suit the different steps or speed changes. Those gears that belong to one of the cones of the countershaft have large holes and those that belong to the other cone have smaller holes. In other respects the gears are like ordinary gear wheels having a hub on each side.



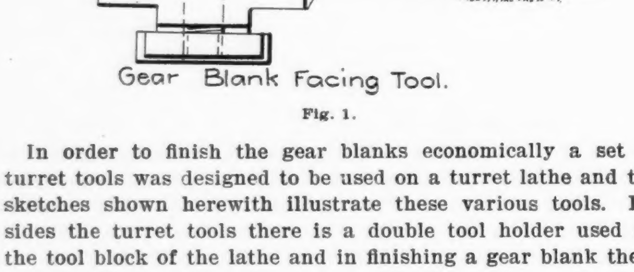


Gear Blank Facing Tool.

Fig. 1.

In order to finish the gear blanks economically a set of turret tools was designed to be used on a turret lathe and the sketches shown herewith illustrate these various tools. Besides the turret tools there is a double tool holder used on the tool block of the lathe and in finishing a gear blank there are six distinct operations, one with the tools on the tool block and five with the turret tools.

The gear is held in the lathe chuck by means of one end of the hub which is gripped on the outside by the jaws of the chuck. The first operation is to rough out the sides of the blank by means of the double holder shown in Fig. 1.

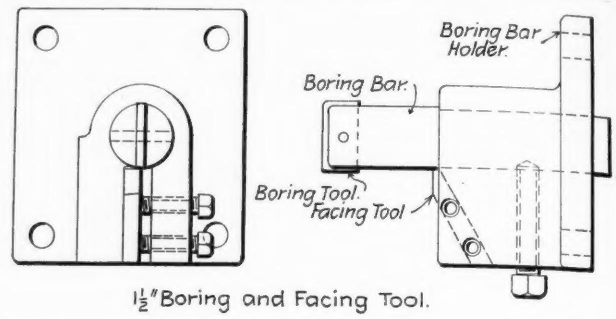


$3\frac{7}{16}''$ Rose-Bit.

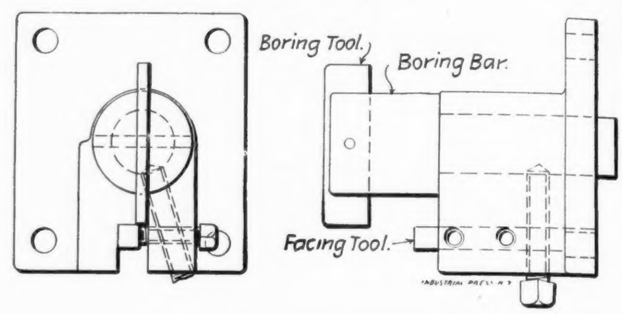
Fig. 4.

It will be seen that there are two holders pivoted at *A* and *B* on a plate designed to clamp to the T-slot of the tool block of the lathe. Either one of the holders may be swung into or out of position as desired and as clearly indicated in the sketch. When either one is swung into position a dowel pin locates it in its proper place. Each of these tool holders carries two cutting tools which, in one case, are spaced far enough apart for roughing out the sides of the gear blank and in the other case for finishing the gear blank to the desired width.

The second operation is to bore the hole in the gear blank. The boring tools are clearly illustrated in Fig. 2. They are made in two sizes, one for the gears having the small holes and the other for the gears having the large holes. They are designed to bolt to the face of the turret, and are located concentric with the axis of the lathe spindle by a cylindrical plug which fits the hole in the turret. The boring tools are double-end cutters, fitting in a slot in the end of short boring bars, which latter are held in the tool



$1\frac{1}{2}''$ Boring and Facing Tool.

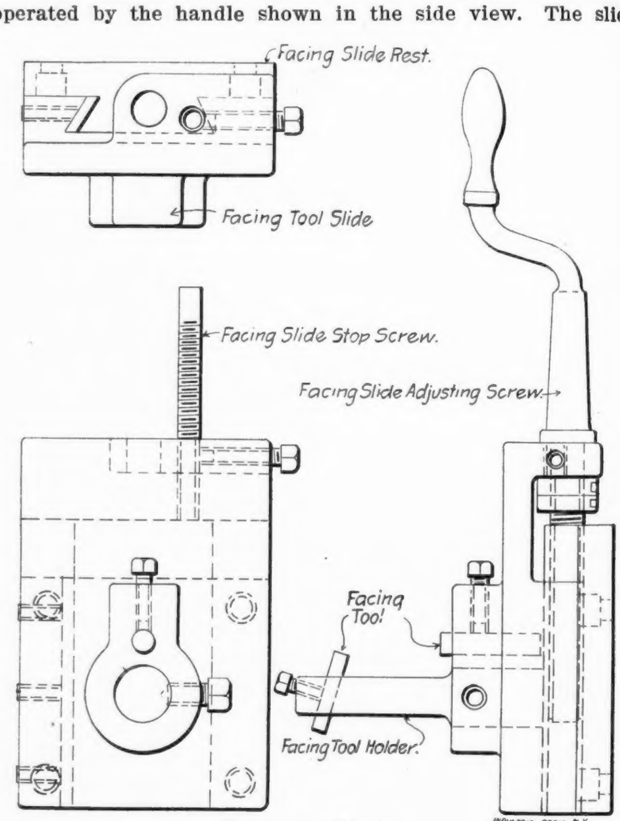


$3\frac{7}{16}''$ Boring and Facing Tool.

Fig. 2.

holder by means of setscrews. These holders also carry facing tools for facing the outer ends of the hubs, after the boring has been completed.

The third operation is to "single end tool" the hole and to face the rear of the hub and a boring and facing tool shown in Fig. 3 is used which bolts to one of the faces of the turret. It has a slide dovetailed to the main casting, this slide being operated by the handle shown in the side view. The slide



Facing Slide.

Fig. 3.

carries a tool holder long enough to extend through the hub of the gear, so that the cutter carried at the outer end of the holder will be in a position to bore the hole when the turret is fed forward and to face the rear end of the hub when the slide is moved vertically by means of the handle. The upper

left-hand edge does the boring and the upper right-hand edge, the facing. To make the length of the hub come accurately to dimensions a pin is inserted in the slide directly above the tool holder, which acts as a stop or gage pin. The turret is moved toward the work until this pin bears against the end of the hub which has already been faced; and by moving the slide the rear end will then be faced by the cutting tool at the end of the holder, which is at a fixed distance from the pin. A stop screw is provided for the vertical adjustment, also, in order to maintain a constant size of hole.

To complete the operation of boring, the holes are finished by reaming, the reamer for the smaller hole being a 1½-inch reamer, and the one for the larger hole being a special design with inserted blades, as shown in Fig. 4.

The fifth operation is to rough turn off the face of the gear. The fixture is shown in Fig. 5 and consists of a casting *A*, bolted to the face of the turret, and a slide *B* which carries

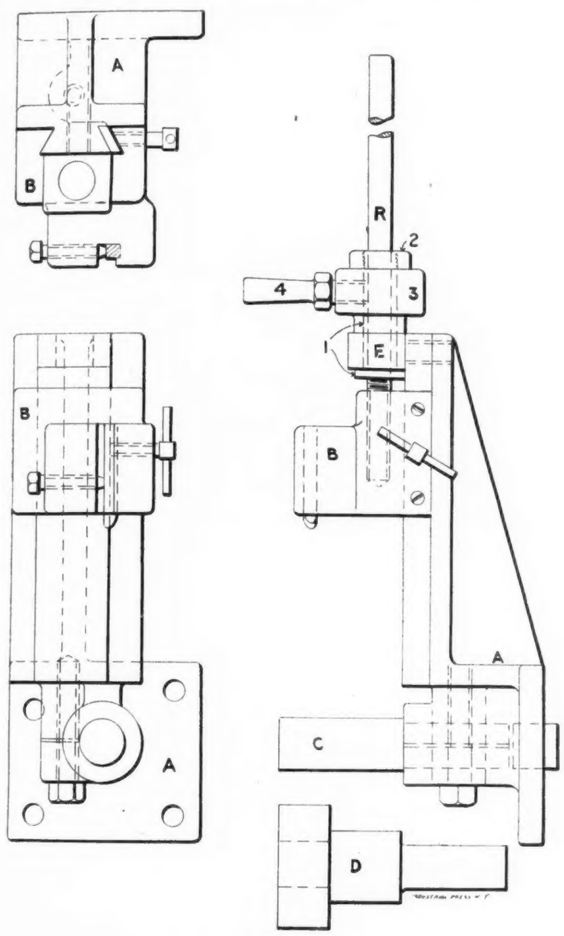


Fig. 5.

the turning tool. In order to support the gear blank securely during this operation, a plug *C*, which is clamped in the casting *A*, is turned to the exact size of the bore of the gear blank; and when the turret is moved up to the work the plug enters the finished hole and steadies the gear during the turning. For the gears having the larger holes a plug like that shown at *D* is used, on the end of which is a roll of the right outside diameter to fit the bore of the gear.

As the outside diameters of the gears vary considerably, it is desirable to be able to adjust the tool holder *B* either a large or a small distance in a vertical direction, both quickly and easily. The means adopted for this is somewhat novel. A rod *R* screws into the tool slide *B*. When everything is free the rod and the slide *B* can be moved together either up or down, both of them sliding freely. To accomplish the fine adjustment the various parts through which the rod passes are bored out large enough to admit the bushing marked 1, the inside diameter of which is such as to allow the bushing to be slipped over the rod. At its lower end this bushing has a collar which bears against the under side of the guiding piece *E*, which latter is fast to the main casting *A*. A collar, 3, slips over the bushing, and lastly a nut, 2, is screwed onto the upper end of the bushing, thus holding the bushing in place. A handle, 4, screws into the collar, 3, and passing through a hole in the inner bushing can be clamped or set against the rod *R*. Now it is evident that when the rod *R* is clamped by the handle, 4, if this handle be moved one way or the other it will cause the rod to turn one way or the other and so screw into or out of the tool block *B*, and cause the latter to be raised or lowered a slight amount. The thrust in moving the tool block is taken up in one direction by the collar on the lower end of the bushing and in the other direction by the nut 2 screwed on the upper end of the bushing. When, however, the handle is unscrewed so as to release the rod *R* the slide *B* can be moved freely up or down to the desired position.

The sixth operation is to finish turning off the face of the gear. This is done with the same kind of tool as is used for the fifth operation.

This completes the gear blank unless it is thought best to finish facing the sides of the blank after the other operations have been performed, in which case the tools carried by the second tool holder attached to the tool post would be used at this time instead of at the beginning when the roughing is done.

* * *

A POUND OF NAILS.

In a lecture before the Stevens Engineering Society, Hoboken, N. J., an abstract of which was published in the Stevens Indicator, Mr. William Kent discussed the modern tendency toward the concentration of industrial forces and the effects of such concentration upon labor and the products of manufacture. He believes that the impending industrial revolution marks a permanent change in manufacturing methods and in conducting business and believes the final outcome will be to the benefit of mankind. Contrasting the old with the new, he says:

"The great work of the 19th century was the emancipation of labor from the drudgery of hard and poorly paid toil, and the use of the steam engine and other machinery to increase the productiveness of labor. The use of machinery has caused the discharge of millions of men from one kind of employment and given them better employment at higher wages.

"The work of the 20th century will be the rearrangement of industry and commerce, so that other millions of men will be discharged from doing labor which this rearrangement will render useless, and so that thousands of steam engines and hundreds of thousands of inefficient machines will be destroyed and their place taken by better machines in better locations.

"Let us take an imaginary case to illustrate what the coming rearrangement means. Suppose a man bought a pound of wire nails a few years ago in New York city. How many different corporations, firms and individuals entered into the problem of furnishing him this pound of nails? The iron ore was mined in the Lake Superior district by a firm whose office was in Cleveland, O. They contracted with a railroad company to carry it to Duluth; and with the owner of a steamer or sailing vessel to deliver it on the dock at Cleveland. There it was sold to the owner of a blast furnace in Youngstown, through the employment of selling agents, and after much dickering about price.

"The furnace man bought his coke in Connellsville, Pa., paying a good profit, of course, to the owner of the coke ovens, which profit no doubt was large enough to cover the risks of competition with other coke producers and other business risks. The pig iron was sold to a maker of steel in Pittsburg, who turned it into steel billets. These were bought by the wire rod maker at another place in Pittsburg, and were perhaps hauled there by horse and wagon, to avoid the high terminal charges for short distances by the railroad. The wire rods were bought by a nail works in Wheeling, and there made into nails and put into the warehouse. If the market happened to be overstocked with nails they lay there for months. Finally they were sold through a Pittsburg broker to a wholesale dealer in New York, who employed salesmen to distribute them to the retail dealer, who after a while sold them to the final purchaser. Think of the handling and rehandling, the business risks of buying raw material at too high a price, and of overstocking the market

and having to sell below cost, of the amount of capital used by the numerous manufacturers, transporting companies and dealers, of the amount of money spent in advertising, and in the employment of traveling salesmen. If the time were the year 1897, when the pound of nails sold for less than two cents, think of the struggles of the several manufacturers to avoid losses, of the reduction of wages, of strikes against such reduction, of the cut-throat competition to sell, which makes profits a vanishing quantity. If the year were 1899, with prices increased over 100 per cent, think of the profits made by those who bought the raw material cheap and sold the manufactured product dear; if the year were 1900, think of the losses sustained by those who were caught with contracts to buy raw material at high prices, and with the sudden decline in demand and in price for the finished article.

"Let us look ahead a few years and see how the situation will be changed. A giant corporation with enormous capital has offices in New York. It owns mines on Lake Superior, railroads to the docks on that lake, steamships carrying the ore to its blast furnaces, steel works, rod mills, and nail works, all located at one place on Lake Erie, steel barges to carry its product through the Erie Canal to its great storehouse on the Hudson River, in New York city, which is part of a vast hardware department store where the product is sold both wholesale and retail. What a saving has been accomplished in human labor, in handling and rehandling, in transportation, in the work of salesmen, in advertising, in cost of carrying stocks of material through every stage from the ore to the finished nail.

This is the industrial revolution that is now impending in the first year of the new century. Shall we complain that its effect will be to destroy the value of hundreds of small iron works and nail mills, that it means less tonnage for railroads, and the discharge of thousands of laboring men, of foremen and superintendents, and of traveling salesmen? The complaint will be a vain one. As well might we complain that the factory system has destroyed the domestic spinning wheel and the household weaving loom, that the locomotive has destroyed the stage coach, that the steel rail has supplanted the iron rail, that the Bessemer converter and the open-hearth has supplanted the puddling furnace. The new industrial and commercial revolution is coming and coming to stay, and in the end will prove as beneficial to the human race as the other revolutions which have preceded it."

SHOP CHARGES.

SYSTEM USED BY THE GRANT TOOL COMPANY.

The following scheme for charging the miscellaneous expenses of a machine shop or manufacturing plant cannot fail to be suggestive to shop accountants and cost keepers, or to those who are organizing a cost system. It is a comparatively easy matter to obtain the direct costs of manufacturing, and to arrange a cost system so that the exact charges for material and the exact time required for the labor upon each piece or a machine being menufactured can be determined at any stage of the process of its production. The incidental and indirect charges, however, are not so easily controlled and are usually both unruly and seemingly excessive in amount, and it is seldom the case that the charges are so made that it can be told just where the money has gone, or at least what department should bear the expense.

The system outlined below, for charging these miscellaneous expenses, is in use at the Grant Tool Co.'s works, Franklin, Pa. Large cards are posted at convenient points in the shops and on them are printed the numbered paragraphs given below, which enumerate the various items of indirect expense connected with the operation of the works. It will be noted that in this enumeration are included both miscellaneous supplies and miscellaneous work. When supplies are purchased or work is done, not directly connected with the production of the machine shop products having order numbers to which time and material are to be charged, the charges are entered under the order number given below. Thus, all the items in the first paragraph are charged to account number five, and in a similar manner the order numbers assigned to the various paragraphs are to be used for work, supplies or material enumerated in the corresponding paragraphs.

LIST OF MISCELLANEOUS SHOP CHARGES.

NO. 5. OFFICE EXPENSE.

Salaries paid for time expended on office work; Blank Books, Stationery for exclusive use of office; Fuel for office, Grates, Oil or other material for lighting; Rubber Stamps, Postage Stamps, Feather Dusters and Brooms; Salary of Janitor and other help in cleaning office; Repairs to Office Furniture; Letter Files; Paper (water closet); Water used exclusively for office; Window Shades in offices.

NO. 6. DRAFTING ROOM EXPENSE.

Salaries paid for work in this department that are not charged direct to any special contracts, Shop Orders or known accounts; all necessary Stationery, Drafting or other material; Oil or other material for lighting; Feather Dusters and Brooms; Paper (water closet); Water used exclusively in this department; Window Shades in this department.

NO. 7. MISCELLANEOUS SHOP EXPENSE.

Brooms for shop use, Brushes, scrub, Paint and Counter, Cans, Oilers other than those used on Account No. 16 (Power and transmitting fixtures) Emery Powder, Paper or Cloth other than that used on patterns, Account No. 12. Material—Charge it to No. 17 where time expended on same is charged to No. 17. Oil—used on Lathes, Planers, Bolt Cutters, and other like shop appliances that are not included in power cost No. 9; Paper for water closet in shop; Pails for shop and forge use; Soda Water used on planers; Sand Paper other than that used on patterns on Account No. 12; Soapine and Soap used for cleaning shop and closets; Time, day and night watchman and doorkeepers; Time attending to heater; Time of Crane Operators; Time Cleaning Shop, Closets, etc.; Time Removing Scrap; Time Removing Cinders from Forges and Furnaces; Time Oiling and Cleaning Shop Power and Hand Tools; Waste used in shop and other than that used on Account No. 9 (Power Cost); Water for Shop Use.

NO. 8. FORGE FUEL.

Coal, Coke or Oil Used in Heating Ovens; Coal, Coke or Oil Used in Forges; Coal or Coke Used in Furnaces; Coal or Coke Used in Blacksmith Forges.

NO. 9. POWER COST.

Cans, Oilers Used on Power Transmitting Fixtures; Coal Used Exclusively for Making Steam; Oil Used on Engines; Oil Used on Pumps, in Stoker, in Line Shafts, in Counter Shafts; Paint or Black Varnish Used on Engine, Paint or Black Varnish Used on Stoker; Paint or Black Varnish Used on Pump, Paint or Black Varnish Used on Boiler Fixtures; Time of Engineer and Time Handling Steam Coal; Time Removing Ashes and Cinders from Boilers; Time Oiling Line and Counter Shafts; Time Extended on Repairs or any other necessary work done to power and transmitting fixtures to keep them in running order; Waste Used by Engineer; Waste Used by Oiler on Line and Counter Shafts; Water Used for Generating Steam.

NO. 10. TEAM ACCOUNT.

Coal used in Warming Barns; Feed, including Hay, Straw, Bran, Corn, etc.; Grease used on Wagons or Harness; Horses; Harness; Stove, including Pipe and Other Fixtures in Barn; Stable Tools, including Shovels, Forks, Wagon Jacks, Brushes, Brooms, Dusters, etc.; Services of Teamster and other help for like purposes; Oil for Lighting, Harness or Lubricating Oils (see stable tools); Water used in barn.

NO. 11. MATERIAL AND MERCHANDISE.

Material of all kinds bought for manufacturing, or partially or wholly manufactured; Freight, Cartage and Switching Charges, unless for some specified account or order.

NO. 12. PATTERNS COST.

Alterations, Bees-Wax, Brushes, Brads, Brass, Glue, Iron, Fillet (leather), Lumber, Nails, Oil, Paint, Putty, Plaster Paris, Rapping Plates, Repairs to Patterns, Shellac, Solder, Screws, Time of Employees in making patterns or any other material for like purposes. The cost of alterations made on patterns for any special contract or order, charge direct to said contract or order.

NO. 13. FURNITURE AND FIXTURES.

GENERAL, PRIVATE AND SHOP OFFICES.

Blue Print Frames, Cases of Drawers for Drawings, Case for Drawing Paper and Tracing Linen, Case for Bills of Material, Work Cards, etc., Clocks in offices and shop, Comptometers, Check Perforator, Cupboards in offices, Chairs, Desks, Drawing Instruments, Fire Screens, Filing Cabinets, Lamps, Printing Presses, Racks for Blue Prints, Safes, stands for letter presses, stools, Surveying Instruments, Typewriters and Stands, Tables, Water Cooler and Filter in office.

NO. 14. ELECTRIC POWER AND LIGHTING PLANT COST.

Generators, Dynamos, Motors, Wires, Lamps, and any other material of a like nature used in erecting this plant or extensions or additions to this plant. Repairs and Renewals to this plant, charge to Account No. 25.

NO. 15. SHOP HEATING PLANT COST.

Fans, Engines, Heating Pipes, Steam Pipes to convey steam to and exhaust from heaters, Valves and other Fittings, Covering for Steam Pipes; Pipes and Fixtures for distributing hot air and any other material of a like nature used in erecting this plant, extensions or additions to this Plant. Repairs to this Plant, charge to Account No. 25.

NO. 16. POWER AND TRANSMITTING FIXTURES.

Air Compressor, Boilers (steam for operating works), Bearings (journal), Blowers (pressure

for forges, etc.), Belt Shifters, Covering for Steam Pipes used in connection with any of the machines included in this account; Exhaust Fans drawing smoke from forges, etc.; Exhaust Fans for Emery Wheels; Engines; Filter (water for engine); Fittings for any fixtures herein; Hangers for Main Line and Sub-Line Shafts; Hoods for Furnaces and Forges; Heater (water for engine); Hot Well, Oilers; all Oilers used on any of the machines or bearings in this Account. Piping—all steam pipes used to convey live or exhaust steam to and from any of the machines in this Account. Piping—all Pipe conveying air to or from forges, furnaces, etc. Pump for Testing Boilers; Pump for Filling Boiler, Stokers (American); Shafting—all Main Line and Sub-Line Shafting, all Countershafting other than that charged with machines. Valves (globe) and other valves in steam pipe charged to this Account, Valves or Windgates in blower or exhaust pipes; Water Tank; Extensions or Additions to Machines, Fixtures or Implements (not including repairs) charge to Account 9.

NO. 17. HAND TOOLS AND APPLIANCES.

Articles enumerated below; Angle Plates, Anvils, Augers of all kinds, Arbors, Bars (crow); Bars (pinch); Bars (pin); Bevels, Bolts in shop used as tools, Blocks and Tackle for shop use; Blocks (flange) Boring Bars, Button Sets, Crabs, Chisels (hand), Chisels-Handled, Chucks, Clamps (Wood, Steel or Iron), Counter Tools, Cutters (blade shape), Cutter Heads, Dies, Drift Pins, Drills, Drill Appliances, Lathe Dogs, Old Men, Oil Tank for Main Shop, Parallels, Punches (hand), Punches (handled), Punches (machine), Files, Forges (portable) for shop use, Fullers, Flatters, Gear Cutters or Collars, Gauges, Hammers, Hydraulic Jacks, Jack Screws, Lamps (oil lighting), Letters and Numerals (steel), Mandrels, Milling Cutters, Punches, Pipe Fitting Tools, Plates (bending), Plates (straightening), Plates (surface), Reamers, Ratchets, Saws (hand, band, cross cut), Sockets for Drills, Sims, Squares (carpenter, try, etc.), Steel Tapes, Slings, Taps, Tools (lathe and planer), Vises, Wheels-Dry and Wet Grinders, Punching Machine (hand), Straight Edges, Sledges, Swages, Sets, Scrapers, Stock and Dies, Tackle and Blocks, Tongs, Tapes (measuring), Wrenches of all kinds.

NO. 18. SHOP POWER TOOLS.

All Machine Tools run by belt or other power; also additions or permanent improvements to any special machine, not including repairs, especially those enumerated below; Boring Mills, Belt Cutters, Benching Rolls, Blacksmith Forges (fixed), Blacksmith Forges (heating); Chucks that are usually furnished with machines and which constitute a part of same; Countershafts and all other appliances furnished with machine; Cutting Off Machine; Cartage paid by us on machines; Drilling Machines; Forges (blacksmith); Forges (heating); freight paid on any machine in this account; Gear Cutters, Grinders (wet and dry), Grind Stones; Hammers (Power); Hammers (Steam); Heating Oven; Hydrostatic Press; Key Seater; Lathes; Milling Machines; Nut Tappers; Planers (straight line or Rotary for Iron or Wood); Pneumatic Drills, Punching Machines, Riveting Machines; Slab Milling Machines; Sawing Machines (Band, Rotary or Jig for iron or wood); Shears, Shears Alligator, Straightening Rolls, Slotters, Spliners, Upsetters. Repairs to Shop Power Tools charge to Account No. 47.

NO. 19. BELTS.

Belts bought after June 1, 1901, that are to be used on shop power tools, power and transmitting fixtures, electric power and light plant. Those for use on hand tools and appliances charge to Account No. 17.

NO. 21. INVENTORY EXPENSE.

Time expended in arranging stock or listing same; Books and Stationery used; all other necessary expenses incurred in completing same.

NO. 22. REAL ESTATE.

Real estate at cost, Railroad Tracks on same, Special Assessments for improvements; Sewers in street and on property; Sidewalks; Paving and other expenditures of like nature.

NO. 23. TRAVELING EXPENSES.

All money expended in traveling on the Company's business when not chargeable to some designated account, order or contract.

NO. 24. ACCIDENT EXPENSE.

Ambulance Service, Nurses' Service, Doctors' Service, Hospital Care, Medicine required and all other expense incurred on account of accidents to employees while at work for us.

NO. 25. BUILDING REPAIRS.

Material and Labor required to keep buildings in good condition. If the repairs in the opinion of the Superintendent will cost $5.00 or over, have a special shop order issued for the work. Note: (This does not include additions or permanent improvements.)

NO. 26. LITIGATION.

All expenses of litigation arising from suits brought by the Company or against it unless on account of accident to employees.

NO. 27. OFFICE BUILDING COST.

All additions and permanent improvements to same. Note: (This does not include repairs)—charge to Account No. 25.

NO. 28. BARN BUILDING COST.

All additions or permanent improvements to same. Note: (This does not include repairs)—charge to Account No. 25.

NO. 29. DINING ROOM EXPENSE.

Wages paid Cook and other Labor; Coal, Wood, Coke or Gas; Water Rent; all other expenses, not including Food Supplies.

NO. 30. DINING ROOM FOOD SUPPLIES.

All Food Supplies for Dining Room.

NO. 31. OFFICE HEATING PLANT.

Material and Labor expended in extending or enlarging plant. Note: (This does not include repairs.) Repairs to be charged one-half to Account No. 5, and one-half to Account No. 6.

NO. 32. MATERIAL MANUFACTURED.

All Material manufactured on shop orders which is not sold. Note: (Material must *not* be made on this Account.)

NO. 33. BUILDING A. (OFFICE BUILDING.)

All Additions and Permanent Improvements to same. Note: (This does not include repairs.) Repairs charge to Account No. 25.

NO. 34. BUILDING B. (MACHINE SHOP.)

All Additions and Permanent Improvements. Note: (This does not include repairs.) Repairs charge to Account No. 25. (Note.—There are similar paragraphs referring to the other buildings.)

NO. 40. JIGS, FORMERS AND TEMPLATES.

Material and Labor expended in making any of the above-named articles. Note: (None of the above-named articles must be made until instructions for so doing have been received from Superintendent of shop.) When any of the above articles are required, the Superintendent of shop will decide as to the cost of the article called for. If it will cost $2.00 or over, it must be made on a shop order, issued for that purpose, which will be drawn when requested by the Superintendent. Each individual Jig, Former and Template must have its individual number stamped or otherwise put upon it. A book must be kept giving a list of all articles in this account. The cost of all articles made for this account must be reported to the general office as soon as completed.

NO. 41. CRANES, TROLLEYS AND PULLEY BLOCKS.

All cranes used at works; all trolleys used at works; all Pulley Blocks used at works.

NO. 42. SHOP EQUIPMENT.

Barrows, Benches in center of shop, Bins in shop for nuts, Bins in stock room; Cars, Push around Shop; Cars, push on railroad track; Cupboards in shop; Drawing Boards in pattern shop; Galvanized Pans; Horses for bridge and other material; Horses in yard; Horses in shop on which machines are put together; Ladders; Layout Tables; Racks for storing tools; Racks for storing material in shop and yard; Roller Tables; Roller Stands; Scales (tracks), Scales (wagon), Scales (shop and yard); Shanties and Sheds in yard; Stove and Pipes used in Shanties; Steaming Boxes for wood bending; Tool Stands; Trucks (timber); Tracks (temporary, consisting of rails and timber); Trucks (hand), Trucks (push around shop); Water Cooler in shops.

NO. 43. MAINTENANCE OF SHOP OFFICE.

Books, Blanks and Stationery used in same; Towels used in same; Washing of Towels for same; Water Rent; Soap and all other materials required for this purpose; Wages of Clerks in same; all other Material and Labor used for this purpose; Paper (water closet).

NO. 44. SUPERINTENDENCE IN SHOPS.

Salary of Superintendent; Salary of Assistant Superintendent; Salary of Foreman of Machine Shop; Salary of Foreman of Blacksmith Shop; Salary of Foreman of Ball Shop; Salary of Foreman of Pattern Shop. Wages of Sub-Foremen when unable to charge direct to designated account, order or contract.

NO. 45. MAINTENANCE OF STORE ROOM.

Books, Blanks and Stationery required, Towels used in store room; Washing Towels; Water Rent; Soap and all other materials used for this purpose; Labor of Clerks and Helpers in same; Labor in delivery of material when unable to charge to account or order on which time is expended.

NO. 46. MAINTENANCE OF TOOL ROOM.

Time of Boys delivering and returning tools; Time of Foreman of Tool Room; Time of Machinist in Tool Room; Time of Helpers in Tool Room—except, when working on shop order charge to the order; When making new tools, charge to Account No. 17. When repairing tools, charge to Account No. 47.

NO. 47. REPAIR TO HAND TOOLS, SHOP POWER TOOLS, SHOP HEATING PLANT, SHOP EQUIPMENT AND CRANES.

Handles (wood for all purposes); Material used in repairs only; Labor expended in repairs only.

NO. 48. OPERATING ELECTRIC POWER AND LIGHTING PLANT.

Labor required in Engine Room, Running Engine, Air Compressor and Generator; Labor Looking After lines and Repairing Same; Oil, Waste and other Material required in running machines in engine room; Material required in looking after and repairing lines; Lamps, Globes and Carbons for Renewals.

NO. 49. FOUNDATIONS FOR SHOP POWER TOOLS, POWER TRANSMITTING AND FIXTURES.

Labor in excavating for foundations, Material used in foundations, Labor filling around foundations, labor in relaying floor where same had to be removed to build foundation.

Placing Shop Power Tools and Power. Transmitting Fixtures Permanently, ready for Power Connection.

NO. 50. PLACING SHOP POWER TOOLS AND POWER TRANSMITTING FIXTURES PERMANENTLY, READY FOR POWER CONNECTION.

Labor and Other Expenses in unloading and moving same to position. Material and Labor used in fastening same to position; Material and Labor used in erecting countershaft ready for belt connection; labor making belt connections.

NO. 51. CORRECTING ERRORS ARISING IN MACHINE SHOP.

Material and Labor expended in replacing which (for any cause arising in this department) has been rendered unfit for the use intended. Before ordering any material or doing any work to replace defective material, the matter must be referred to the Superintendent of shop who will instruct whether the work will be replaced on the parent order or on a separate order drawn for that purpose. If material to be replaced will cost $2.00 or over the Superintendent must see that the replacing is done on a separate shop order which will be issued for that purpose at his request.

NO. 52. CORRECTING ERRORS ARISING IN FITTING DEPARTMENT.

(See Account No. 51.)

Similar references to errors arising in the other departments.

NO. 56. REPLACING DEFECTIVE MATERIAL.

Charge to this Account.

Material and Labor required to replace material found defective after work has been done on it. In replacing follow instructions given under Account No. 51.

NO. 57. CORRECTING ERRORS ARISING IN DRAFTING ROOM.

Charge to this Account.

(See Account No. 51.)

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JANUARY, 1902.

THE BONUS SYSTEM.

In any attempt at cost reduction by means of some one of the various schemes for payment of wages, other than paying by the day, such as piece work, premium plan, piece rate system, etc., the object sought is to induce the workman to produce more work than he would if left to his own resources and inclination. Some systems *force* a man to work harder, and perhaps very much harder, in order to earn a fair day's pay; and if he does not work very much harder his reduced wages amount to a forfeiture or penalty imposed upon him in consequence.

If strict justice, only, were required in this world, there could be but little fault found with such a system, which compensates a man for what he actually does—no more, no less. Experience shows pretty conclusively, however, that it is more effective to lead a man than it is to drive him, and the more agreeable the means taken to lead him, the better will be the results. For this reason we believe it is better to guarantee a man a fair daily wage, and then to pay him a premium in some form or other, if he does well, than to pay him strictly according to his production, which, as explained, amounts virtually to a forfeiture in some cases. While it may be argued that if a man earns less he should be paid less, it is just as fair to fix his day rate according to his ability to turn out work and then to give him the opportunity to earn more if he can.

Last month we explained how the piece work system, pure and simple, might be so modified as to be conducted upon this plan, and that when so modified it would not be unlike some of the more modern methods of wage payment. In another column of this number is a brief extract of a paper by H. L. Gantt, presented before the American Society of Mechanical Engineers, upon a bonus system for compensating labor. This system is in use at the works of the Bethlehem Steel Co. and is based on the plan of paying a man a regular day rate and a bonus in addition, if he earns it. Each workman is given a card on which are carefully prepared directions for performing all the operations on the the piece that he is to work upon and the estimated time for completing each operation is also written on the card. This plan is carried to such an extent that even the necessary time for changing a piece end for end, for adjusting the change gears of a lathe, etc., is accounted for and the particular kinds of tools or steel for tools, the feeds and speeds, etc., are specified. With this information given him the workman goes to work, and if he completes the piece in the time specified he receives a bonus; otherwise he obtains only his regular wages.

* * *

PLANNING A MACHINIST'S WORK.

The custom of making out a complete list of operations to be followed by a machinist in producing a piece of work is coming more and more to be adopted, and is one of the developments incidental to modern methods. While the custom may be resented by some, who will look upon it as only another step in the direction of making a machine out of what was a machinist, or of placing a man in the position where he is "paid to work but not to think," we believe that such a result is far from what is actually attained. Machine shop methods have been developed to such an extent and in such a multitude of directions, that the machinist who does the work, or anybody else for that matter, cannot tell offhand just how it is best to machine a piece, and what speeds and feeds, or what tools, even, will be the most effective. Yet he or his foreman is frequently depended upon to turn out the work at small cost in a haphazard way, without having time to actually study the conditions. So it is that the plan is growing in favor of having a practical man or men, as the case may be, to gather data upon the capacities of the various machine tools; of the capabilities of different brands of steel; of the time required to handle work, and of the operations that appear to be best adapted to each piece of work and the order in which they should be performed. Such men should themselves be skilled machinists who can go to a tool and demonstrate, if necessary, that the work can be done as they direct, and in the time set, should their figures be doubted.

We have in mind a firm who took a large contract for government work with which they were very successful. Another firm took a contract for the same kind of work and failed, and were obliged to turn over their contract to the first firm. The reason why one firm was successful and the other was not was because one planned out every operation and every jig beforehand and the other did not.

If the plan outlined above should come into more or less general use, how will it affect the machinist? The machinist has always been called a thinking man, but instead of converting him into a dummy, this should lead him to rack his brain more than ever. It is like placing him at school. He will be directed how to do work according to a carefully thought out plan, and he will naturally question why this or that way was adopted and will finally begin to plan out ways for himself. He will become more skilful and will himself devise improved methods, which, under a system like that at Bethlehem, will be rewarded in cash. We see no reason to fear any bad results from the system, so far as the machinist is concerned, because it will afford every operator a chance to learn more and to become a more expert workman, which always has reacted and will always react to the direct benefit of the workman, financially and otherwise.

* * *

NOTES AND COMMENT.

But little has been heard of the new Edison storage battery since the announcement of its invention and the explanation of its principle of construction last May. According to the *Electrical World and Engineer*, however, the battery will probably be on the market and for sale by next spring. The Edison Storage Battery Co. was organized with a capital of $1,000,000 last June, and since then there have been active preparations for the manufacture of the new battery. A new factory is being equipped at Glen Ridge, N. J., and it is expected that its initial output will be about 100 horse power daily. Two other plants have been erected for the enterprise at other localities, one for preparing iron oxide and graphite and the other as a distillation plant. In the meantime Mr. Edison and his assistants are at work to improve the battery in every possible way. While the battery is announced to weigh only about one-third as much as the older types of like capacity, it is not by any means what may

be called light weight. A single cell of the battery exhibited at Buffalo, 12 inches high, 2 inches thick and 5 inches wide, weighed 7½ pounds, and had a capacity of about .16 horse power per hour, or the assembled battery would weigh about 46 pounds per horse power hour. Assuming a small automobile to require a constant power of two horse power, a small allowance, the battery would have to weigh about 500 pounds to have an endurance of five hours, and as a matter of fact a 750-pound battery would not have any too large capacity.

The power plant in the course of construction on the Susquehanna River, about 16 miles from Harrisburg, will rival any plant of the kind in the country aside from the Niagara Falls plants. The operation consists in the development of an immense electrical power plant which will utilize nearly all of the water in the river by diverting its course at a point called the Falls just above where the plant will be located. There will be built a power house 478 feet long and 51 feet wide, in which there will be 40 turbine water wheels of 600 horse power each, operating twenty 750 kilowatt generators, together with two turbines of 250 horse power each to drive machines for excitation. A contract for the generators has been awarded to the Stanley Electric Mfg. Co., and for the turbines to Robert Poole, Sons & Co., of Baltimore.

It is a peculiar circumstance that there is no unit in common use for measuring large volumes of liquids, other than the gallon, which is equal to only 231 cubic inches. In measuring massive weights we use tons; in linear measure we use the yard, rod or mile for long distances; and in square measures the square yard, square mile, or acre, equal to 4,840 square yards, are all available. In cubic measures, also, large units are used when referring to solids, as for example, bushels, equal to 2,150.42 cubic inches, are employed for grain and cubic yards for measuring earthwork. When it comes to liquids, however, we seldom use a measure larger than the gallon. We never hear of a reservoir holding so many barrels, and cubic feet, even, are seldom employed in this connection. We speak of the reservoir or tank as holding 10,000,000 gallons, or 1,000 gallons, as the case may be. It is like measuring the distance from New York to Philadelphia, a distance of 90 miles, in inches. In stating the distance between the two cities we should then say that it was 5,702,400 inches, which gives one small conception of the actual distance.

GATHMANN GUN EXPERIMENTS.

The tests at Sandy Hook proving ground during the past month with the Gathmann gun and a modern high-power gun firing armor-piercing projectiles were perhaps the most important tests of the kind that have ever been conducted. When armor plate was first made by the Harvey and Krupp processes it was found to be impenetrable by the projectiles then in use, and the charges carried by the projectiles exploded upon impact against the surface of the plate with but little damage to the plate. The Gathmann gun was built to try the effect of exploding still heavier charges against the surface of a plate. The shell carried 500 pounds of gun cotton; and while the gun was built upon the plan of modern steel rifles and its projectiles struck a tremendous blow, it was not designed for armor piercing. The result of the explosion of the shells at the proving ground was to move the plate and backing used as a target several feet from its foundations, and a similar charge fired against a battleship would undoubtedly rack the structure. The actual damage done to the plate, however, was slight.

The high-power gun was tested under as nearly parallel conditions as possible, but the shot passed entirely through the thick armor plate, the small charge carried exploding while passing through and wrecking the plate. The tests seem to conclusively demonstrate that the effectiveness of ordnance has been increased to a remarkable extent, and that inasmuch as a projectile can be made to pierce a plate, the destructive qualities of its charge must necessarily be much greater than can be possible with a much larger charge exploded against the plate.

PIPE COVERING TESTS.

Results of an extensive series of tests by Geo. H. Barrus, the consulting engineer, to determine the efficiency of pipe coverings, have been reported during the past month. These tests were made at the new power plant of the Manhattan Elevated Railway, New York City. The coverings tested were bought in the open market, and the results show that the various kinds of asbestos air-cell covering, which is made in several forms, is the most efficient under the conditions of the tests. The test plant was divided into two sections, one carrying 80 pounds pressure and the other 150 pounds. The high-pressure section included five 2-inch pipes connected to a common header, each 100 feet long, and two 10-inch pipes, each 35 feet long. The 80-pounds pressure section consisted of five 2-inch pipes, each 100 feet long. Precautions were taken to secure dry steam, and the quantity of water collected from the various pipes showed the efficiency of the covering used on those pipes. It was also found that the amount of evaporation was not dependent upon the velocity of flow through the pipes, and so most of the tests were made with pipes having dead ends, the steam flow being only sufficient to take care of the condensation. The coverings ranking first and second, respectively, at 80-pounds pressure, were Johns' Asbestocel and the New York Air Cell. With the 2-inch pipe, 150-pounds pressure, Johns' Asbesto-Sponge Hair Felt, three-ply, stood first, and the two-ply of the same material, second; with the 10-inch pipe, 150 pounds pressure, Johns' Asbesto-Sponge Felted, first, and K. & M. Magnesia (85 per cent Carb. of Mag), second. Other coverings selected for the test, and which did well, were Carey's Moulded, Gast's Ambler Air Cell, Asbestos Fire Felt (Navy Brand) and Watson's Imperial.

MORE DEVELOPMENTS IN RAPID TRANSIT.

MACHINERY has already explained the plan of the Pennsylvania Railroad, first announced in the *Outlook*, to connect Manhattan Island with the New Jersey shore by a mammoth railroad bridge, which was to be used in common by the several railroads having terminals in New Jersey for New York City. It is now definitely announced that this plan is not to be carried through, but that a tunnel will be built under the Hudson, or North River, for the exclusive use of the Pennsylvania Railroad, and that the tunnel will also be extended to Long Island to connect with the Long Island Railroad, recently leased by the Pennsylvania Railroad. It is estimated that the cost of the tunnel will not exceed $20,000,000, which is very much less than the probable cost of the suspension bridge formerly proposed, and it will rank as one of the great engineering achievements, not only because of the enormity of the undertaking, but because of the potent influence that it will have upon travel and the suburban life of people doing business in New York City. It will enable through trains to be run from New England points to southern and western sections of the country by means of a bridge connection between Long Island and the main land, and will facilitate reaching large suburban sections in New Jersey and Long Island.

The new railroad station in New York will have tracks and platforms underground, and from there the tunnel will pass under the North River to New Jersey in one direction, and Long Island in the other direction. The tunnel will consist of from two to four steel tubes about 18 feet in diameter, braced and stiffened to sustain the load of the trains and track, and it will rest on piling foundation beneath the river bottom. Work is to begin at once, or as soon as the necessary permits are obtained, and it is expected that the project will be completed in the early part of 1895. It is quite possible that this commendable and important move on the part of the Pennsylvania Railroad will mean even more to New York City than the rapid transit tunnel now under construction.

* * *

The *Aluminum World* says that the best lubricant to use on aluminum when turning it in a lathe, is either petroleum or water and in the press, when it is being drawn or stamped, vaseline.

ANNUAL MEETING OF THE A. S. M. E.

NOTES ON THE BUSINESS SESSIONS AND ABSTRACTS FROM SEVERAL PAPERS.

The annual meeting of the American Society of Mechanical Engineers was held at the society's house, New York, December 3 to 6, inclusive. The first session opened with an address by the retiring president, Mr. S. T. Wellman, Cleveland, who took as his subject "The Early History of Open Hearth Steel Manufacture in the United States." This address was in the nature of a recital of the experiences and observations of its author, in accordance with what has come to be the usual custom of the presidents of the society in preparing their addresses.

At the first business session was the election of officers as follows: President, Edwin Reynolds, Milwaukee; treasurer, William H. Wiley, New York; vice-presidents, Wilfred Lewis, Philadelphia; M. E. Cooley, Ann Harbor; M. P. Higgins, Worcester; Managers, R. S. Moore, San Francisco; H. A. Gillis, Richmond; C. H. Corbett, Brooklyn.

The motion to increase the dues of the members of the American Society of Mechanical Engineers was defeated at this session, as was quite generally expected. The vote stood 647 to 191, many members who were unable to be present, voting by proxy. The effort to increase the dues on the part of the secretary and certain members of the council naturally led to inquiries as to why this should be necessary, and arguments pro and con. There was a general overhauling and criticism of the management and affairs of the society, and the discussion was extended and at times animated enough to be interesting. The fact, as announced, that the society has been contracting an annual debt for some time without the knowledge of the members at large, or even of all the members of the council, has led to the conviction that there is plenty of opportunity to improve the system of management, and that these improvements should be made before the society attempts to raise more money by increase of dues or otherwise. The admitted ignorance of the affairs of the society by some of the members of the council, at least, appears to us inexcusable.

A committee is to be appointed to investigate the subject more fully, and to consider whether it is practicable to carry on the work of the society in an efficient manner with the present dues. If necessary the books will be audited, and when the report is finally made the members of the society will be in a position to take further action intelligently, if such action is called for.

The next (spring) meeting of the society is to be held at Boston, Mass.

Edwin Reynolds.

The new president, Mr. Edwin Reynolds, is one of the most distinguished engineers who has honored the society in this capacity. Mr. Reynolds was a farmer's boy and learned the machinist's trade in Connecticut. He afterwards held several positions where he was engaged in the construction of machinery, but in this earlier work he became best known after he entered the employ of Geo. H. Corliss, Providence, R. I., then the most prominent engine builder in the country, and of whose works he finally became general superintendent. He later went West to take charge of the E. P. Allis Co.'s works, after the concern had failed, and he has brought this company up to their present commanding position through his own energy and ability. The first move made in the new position was to put the concern on a paying basis, which he did by building the Reynolds-Corliss engine. The first machines were built with the beds of such design that they could be used either for a left or right-hand engine, and in other ways the design was made to fit the tools of the shop and to accommodate the pocketbooks of the builders. At one time a certain new machine tool was needed for the works, and Mr. Reynolds was obliged to give his own note for it. This illustrates the difficulties under which the firm labored.

Mr. Reynolds' work has always been characterized by originality, and he has never hesitated to adopt what appeared to be radical methods, if they appealed to his sound judgment. At the Corliss works he at one time took an order for a 20 by 42 engine for the Trenton Iron works, which, according to specifications, must run at 160 revolutions a minute. This required special valve gear and large ports, and Corliss refused to have anything to do with the order, saying that Reynolds must take the entire responsibility, which he did, and the engine ran satisfactorily. This was a noteworthy achievement for that time.

At the Allis works he has not only engaged in engine building, but in general engineering practice. One of his improvements was the substitution of solid for flexible foundations under steam stamps, the base for each stamp being constructed of 40 tons of cast iron in place of a springy structure, with the result of increasing the output 50 per cent. Another original achievement was the installation of a screw pumping system for Milwaukee, used in connection with the sewage system. The pumps held a form of propeller wheels which forced the liquid ahead in the pipes, the action of the propellers on the liquid being made more effective by suitably arranged vanes, which caught the liquid forced outward by centrifugal force and guided it in a forward direction. His latest and most important work is in connection with the 8,000 horse power engines for the Manhattan Elevated road of New York. These units are so large as to make the usual construction an exceedingly difficult feat, on account of the mammoth flywheels that would be required. Reynolds' design is for a double compound engine having horizontal high-pressure cylinders and low-pressure vertical cylinders, the high-pressure and low-pressure cylinders on each side working on the same crank. This construction gives so uniform a turning moment that no flywheel is required other than the armature of the generator.

The Fulton Memorial.

Among the interesting events of this series of meetings was the dedication of a monument to Robert Fulton, the noted engineer and pioneer in steam navigation. Fulton was buried in Trinity Churchyard, New York, but his grave has never been marked by a suitable monument. During the past two years the society has raised a suitable sum for such a monument, which has recently been erected in the churchyard. The exercises were conducted by Rev. Robert Fulton Crary, of Poughkeepsie, N. Y., a grandson of the inventor. Just before the commencement of the services the society listened to addresses in Trinity Building, adjoining the church, by Rear-Admiral Melville and Prof. R. H. Thurston. Mr. Melville sketched the life and history of Robert Fulton, while Professor Thurston spoke in praise of Fulton as a man. Charles H. Haswell, first Chief Engineer of the Navy, who saw Fulton's first steamboat, the "Clermont," and assisted in the production of his second warship, the "Fulton II.," was present at the exercises.

THE PAPERS.

In the last number of MACHINERY a list was published of the technical papers to be presented at this meeting, and in this number are brief extracts from those that will be of the greatest interest or value to our readers. In addition to the regular papers a final report was made by the committee appointed some time ago to formulate standard proportions for engines and dynamos when used in direct-connected units, and the preliminary report was submitted of the committee previously appointed to formulate standard specifications for engine testing.

BONUS SYSTEM.

The paper which drew out the most comment at the annual meeting of the American Society of Mechanical Engineers was the one by H. L. Gantt, South Bethlehem, Pa., upon "A Bonus System of Rewarding Labor." This system is an attempt at harmonizing the interests of the employer and employe, and, while it affords substantial justice to the employe, requires that he shall always conform to the best interests of his employer.

A card is made out, showing in detail the best method (so far as our present knowledge goes on the subject) of performing each of the elementary operations on any piece of work, specifying the tools to be used, and setting the time needed for each of these operations as determined by experiments.

The sum of these times is the total time needed to complete the piece of work. If the man follows his instructions, and accomplishes all the work laid out for him, as constituting his proper task for the day, he is paid a definite bonus in addition to the day rate which he already gets. If, however, at the end of the day, he has failed to accomplish all of the work laid out, he does not get his bonus, but simply his day rate. As the time for each detail operation is stated on the instruction card, the workman can see continually whether he is earning his bonus or not, and if he finds any operation which cannot be done in the time set, he must at once report it to his foreman. If, on careful investigation by the man making out the card, the workman's statement is found to be correct—that a portion of the task can not be done in the time stated on the card—a new instruction card is made out, explaining the proper method of working, and allowing the proper time. The foremen also receive, in addition to their day wages, compensation proportional to the number of their men who earn a bonus, and an extra compensation if all of their men earn their bonuses.

As these cards are made out by a skilful man, with the records at hand, they invariably prescribe a better method for doing the work than the ordinary workman or foreman could devise on the spur of the moment. As all the appliances and instructions necessary for doing the work are furnished, and a fixed premium or bonus is allowed the workman in addition to his regular rate if the work is done satisfactorily in the time set, it will be seen at once that this method is really a system of education, with prizes for those who learn, and the results already obtained bear out this idea of education most fully, for the author states that under it men have learned more in a few months than they did before in years.

FLYWHEEL TESTS.

For several years tests have been conducted at the Case School of Applied Science, Cleveland, Ohio, to find the relative strength of flywheels of different designs and proportions, and the results of these form the best data we have upon the strength of such wheels at the present time. The tests were made upon small, model wheels, 15 inches to 2 feet in diameter, run at enormously high speeds by means of a steam turbine, until they finally burst. Apparatus was provided for recording the speed at the time of bursting. At the annual meeting of the American Society of Mechanical Engineers in 1898, Prof. C. H. Benjamin gave results of the tests made up to that time and drew the following conclusions:

1.—Flywheels with solid rims, of the proportions usual among engine builders, and having the usual number of arms, have a sufficient factor of safety at a rim speed of 100 feet per second, if the iron is of good quality and there are no serious cooling strains. In such wheels the bending due to centrifugal force is slight and may be safely disregarded.

2.—Rim joints midway between the arms are a serious defect, and reduce the factor of safety very materially. Such joints are as serious mistakes as would be a joint in the middle of a girder under a heavy load.

3.—Joints made in the ordinary manner, with internal flanges and bolts, are probably the worst that could be devised for the purpose. Under the most favorable conditions they have only about one-fourth the strength of the solid rim and are particularly weak against bending. In several joints of this character on large flywheels calculation shows a strength less than one-fifth that of a solid rim.

4.—The type of joint having the rim held together with links is probably the best that could be devised for narrow rimmed wheels not intended to carry belts, and possesses, when properly designed, a strength about two-thirds that of the solid rim.

At the last meeting of the society, Prof. Benjamin again gave some data, deduced from experiments conducted since 1898. Wheels with solid rims were again tested, to afford a standard for comparison by which wheels with jointed rims of various designs could be judged. These burst at a rim speed of 395 feet per second, corresponding to a centrifugal tension of about 15,600 pounds per square inch.

Four wheels were tested with joints and bolts inside the rim, after the familiar design ordinarily employed for band wheels, but with the joints located at points one-fourth of the distance from one arm to the next, these being the points of least bending moment, and, consequently, the points at which the deflection due to centrifugal force would be expected to have the least effect. The tests, however, did not bear out this conclusion. The wheels burst at a rim speed of 194 feet per second, corresponding to a centrifugal tension of about 3,750 pounds per square inch. These wheels, therefore, were only about one-quarter as strong as the wheels with solid rims, and burst at practically the same speed as wheels in the previous series of tests in which the rim joints were midway between the arms. This is doubtless due to the fact that the heavy mass of the flanges and bolts locates the bending moment near them. In these wheels the combined tensile strength of the bolts in the flange joints was slightly less than one-third the strength of the rim, which is about the maximum ratio possible with this style of joint.

Another type of wheel with deep rim, fastened together at the joints midway between the arms by links shrunk into recesses, after the manner of flywheels for massive engines, gave much superior results. This wheel burst at a speed of 256 feet per second indicating a centrifugal tension of about 6,600 pounds per square inch.

Tests were made on a band wheel having joints inside the rim, midway between the arms, and in all respects like others of this design previously tested, except that tie rods were used to connect the joints with the hub. It burst at a speed of 225 feet per second, showing an increase of strength of 30 to 40 per cent over similar wheels without the tie rods. Several wheels of special design, not in common use, were also tested, the one giving the greatest strength being an English wheel, with solid rim of I-section, made of high-grade cast iron and with the rim tied to the hub by steel wire spokes. These spokes were adjusted to have a uniform tension by "tuning," and the wheel gave way at a rim speed of 424 feet per second, which is slightly higher than the speed of rupture of the solid rim wheels with ordinary style of spokes.

COMPRESSION TESTS ON COIL SPRINGS.

A second paper by Prof. Benjamin summarizes the results of tests made at the Case School upon a large number of springs. Over 1,600 were tested. The object of the tests was to find the coefficient of torsional elasticity and the safe stress for springs made of different sizes of bars and having different ratios of diameter of spring to diameter of bar. The formulas given for the safe load for a spring of given proportions and for the deflection of a spring, due to a given load, are:

$$P = \frac{S d^3}{2.55 D} \quad \text{and} \quad x = \frac{L D S}{G d}$$

where P = load in pounds; S = torsional stress in pounds per square inch; G = coefficient of torsional elasticity; D = mean diameter of spring in inches; d = diameter of bar in inches; H = height of spring in inches; L = length of bar in inches; and x = deflection in inches with load P.

The value for G, the coefficient of torsional elasticity, is given in most hand-books as 12,000,000. In these tests the values ranged higher than this, the highest value being 18,900,000 and the lowest 12,500,000. This variation is due both to variation in temper and to slight differences in the chemical constituents of the steel. The average of all the tests is found to be 14,700,000, which may be written 14,500,000 for convenience. The size of bar has much to do with the safe value of S, the torsional stress in pounds per square inch, since it is not possible to work a large bar so that it will be as homogeneous as a small bar. Springs of small diameter may be safely subjected to a higher stress than those of large diameter, but the proportions should not be carried to an extreme, and a spring to have good service should have a mean diameter not less than three times the diameter of the bar.

For a good grade of steel the following values of S have been found safe under ordinary conditions of service, the value of G being taken as 14,500,000. The ratio of the mean diameter of spring to the diameter of bar is expressed by R in the following:

For bars below ⅜ inch diameter:

$R = 3$ $S = 112{,}000$

$R = 8$ $S = 85{,}000$

For bars 7-16 to ¾ inch in diameter:

$R = 3$ $S = 110{,}000$

$R = 8$ $S = 80{,}000$

For bars from 13-16 to 1¼ inches in diameter:

$R = 3$ $S = 105{,}000$

$R = 8$ $S = 75{,}000$

For bars over 1¼ inches in diameter a stress of more than 100,000 should not be used. Where a spring is subjected to sudden shocks a smaller value of S is necessary.

The springs referred to in this paper are all compression springs with open coils. Experience has shown that in close coil or extension springs the value of G is the same, but that the safe value of S is only about two-thirds that for a compression spring of the same dimensions.

ROPE TRANSMISSION.

C. W. Hunt presented a few notes on working loads for manila rope which are summarized in the tables given herewith. This information is from his own and others' experience. The weakening effect of knots as shown in the second table is determined from tests made at the Massachusetts Institute of Technology, Boston. In the first table the work required of the rope is, for convenience, divided into three classes: "rapid," "medium," and "slow," these terms being used in the following sense:

"Slow"—Derrick, crane, and quarry work; speed from 50 to 100 feet per minute.

"Medium"—Wharf and cargo, hoisting 150 to 300 feet per minute.

Working Load for Manila Rope.

A	B	C	D	E	F	G	H
Diameter of Rope, Inches.	Ultimate Strength. Pounds.	Working Load in Pounds.			Minimum Diameter of Sheaves in Inches.		
		Rapid	Medium.	Slow.	Rapid.	Medium	Slow.
1	7,100	200	400	1,000	40	12	8
1⅛	9.000	250	500	1.250	45	13	9
1¼	11,000	300	600	1,500	50	14	10
1⅜	13.400	380	750	1 900	55	15	11
1½	15,800	450	900	2,200	60	16	12
1⅝	18,800	530	1,100	2,600	65	17	13
1¾	21,800	620	1,250	3,000	70	18	14

The Efficiency of Knots in a Percentage of the Full Strength of the Rope, and the Factor of Safety when Used with Stresses, as per Column E, in Table above.

I	J	K	L	M	N	O	P
	Eye-splice over an Iron Thimble.	Short Splice in the Rope.	Timber Hitch, Round Turn, and Half-hitch	Bowline Slip Knot, Clove Hitch.	Square Knot, Weavers' Knot, Sheet Bend	Flemish Loop, Overhand Knot.	Rope Dry. Average of Four Tests from the Same Coil as the Knots.
The Efficiency of the knot.......	90	80	65	60	50	45	100
Factor of safety..	6 3	5.6	4 5	4.2	3.5	3.1	7

"Rapid"—400 to 800 feet per minute.

The diameter of the rope in column A is obtained by dividing the girth by 3.1416. This method gives for a three-strand rope nine-tenths, and for a four-strand ninety-three hundredths of the diameter of a circumscribed circle. The girth method corresponds closely to the circular diameter of the rope when under stress, and is the most convenient method to use.

* * *

A writer in the *American Blacksmith* calls attention to the old trick of softening hard cast iron so that it may be drilled. Heat the iron to a low red and place on the spot where the hole is wanted a piece of brimstone the size of a bean, and let the iron cool off slowly. Use no oil in drilling. If any lubricant is used let it be water or turpentine.

HOW THE VELOCITY OF PROJECTILES IS MEASURED.

Time was when the testing of a gun was, viewed in present lights, a slipshod, unsatisfactory sort of process. Much was taken for granted after the piece had demonstrated its ability to hold together during the strain of discharge. There were few of the "niceties" of gun-test. But now the proving of a gun is a careful and methodical operation. Not only must it hold together, but it must demonstrate its intention to hold together under rapid and continuous use, and it must show itself capable of giving the projectiles a high velocity and a comparatively flat trajectory.

For testing the velocity of the projectiles a chronograph is used, which in this case consists in a general way of three parts—a powerful magnet, a steel rod and a knife-blade. The chronograph is mounted in a structure set at considerable distance from the emplacement upon which the gun to be tested is mounted. This is to obviate jarring when the piece is discharged . At the top of the machine is the powerful magnet which, when the current is closed, holds the rod suspended. The rod hangs over an aperture in the base of the instrument, and at one edge of this opening a knife-blade is placed and held back against a spring by another electro-magnet. The brick foundation upon which the instrument is built goes many feet into the ground in order that the greatest stability may be obtained.

To return to the gun, two square frames are erected on the line of fire, the first one a hundred yards from the muzzle of the gun, and the frames exactly one hundred yards apart. Back and forth across these frames is a network of wires; or rather a cross-weaving of one wire which runs from the frame to the instrument in the distant house, and is connected with the electro-magnet which holds the slender steel rod. The second screen is like the first, save that its wire runs to the second electro-magnet, the one holding back the knife-blade at the base of the chronograph.

Then, with the current on, the rod suspended, the knife-blade restrained against the spring, the gun is fired. The projectile pierces the first screen, the wire is broken, the circuit is opened, the magnet is demagnetized instantly and the rod drops. The projectile speeds across the hundred-yard space and pierces the second screen, breaking its wires and breaking the electric circuit. This releases the knife-blade, past which the rod must fall, and, energized by the spring, the blade flies forward and strikes the rod, making a minute nick upon it. By this time the projectile has flown into the great sand butt and buried itself, and the nicked steel rod has dropped into a sand-filled receptacle. The velocity has been denoted by the utilization of the law of falling bodies. A body will fall 16½ feet the first second, 33 feet the second, and so on in this ratio until it reaches earth. Applying this principle to the rod, it is known that its foot was exactly at the level of the blade, so that measuring the distance from the foot to the nick, gives the space through which the rod has fallen. Then, remembering the gravity law, that a body falls 16½ feet the first second, it is readily determined how long the shot has required to cover the 100 yards between the screens. This gives practically the initial velocity of the projectile.—*N. Y. Evening Post.*

* * *

Short circuits in electrical transmission lines sometimes happen in the most unexpected ways. Not long ago a lady shopper in Boston dropped a brass curtain rod from the platform of a Boston elevated railway station and it fell across one of the rails of the track and also across the third rail through which the current is transmitted. This short-circuited the system and tied up the line. At Hoffman, N. Y., a still stranger accident happened. A cat, of an investigating turn of mind, climbed a pole of the Buffalo and Lockport Electric Railway and attempted to do a tight-rope act on one of the feed wires. Her tail brushed against one of the 22,000-volt lines of the Niagara transmission system, near-by, and she suddenly had one life less to live. The body of the cat short-circuited the current and the power was shut off at Niagara for two hours in consequence.

FIXTURES AND TOOLS FOR MAKING SPEED INDICATORS.

JOSEPH VINCENT WOODWORTH.

The sketches herewith are of two special chucks and of a tapping machine which were designed by Mr. W. J. Parker,

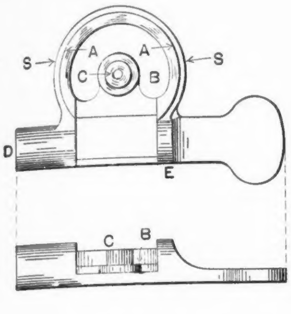


Fig. 1. Sketch of Indicator.

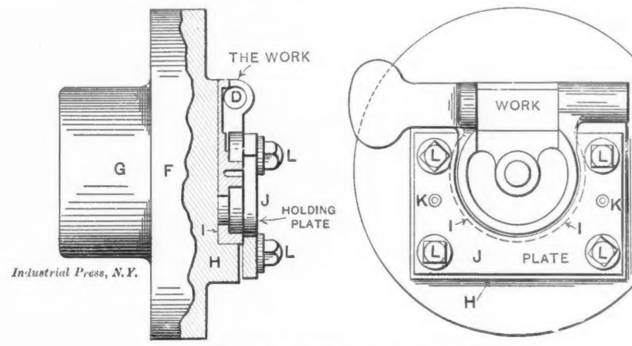


Fig. 2. The Chuck for First Operation.

foreman of the Fulton Machine Works, Brooklyn, the chucks being used for machining a casting which forms the body of a speed indicator manufactured by that firm. The work on this casting was the boring out of the large circular portion *A* for the revolving dial plates of the indicator; the facing of the

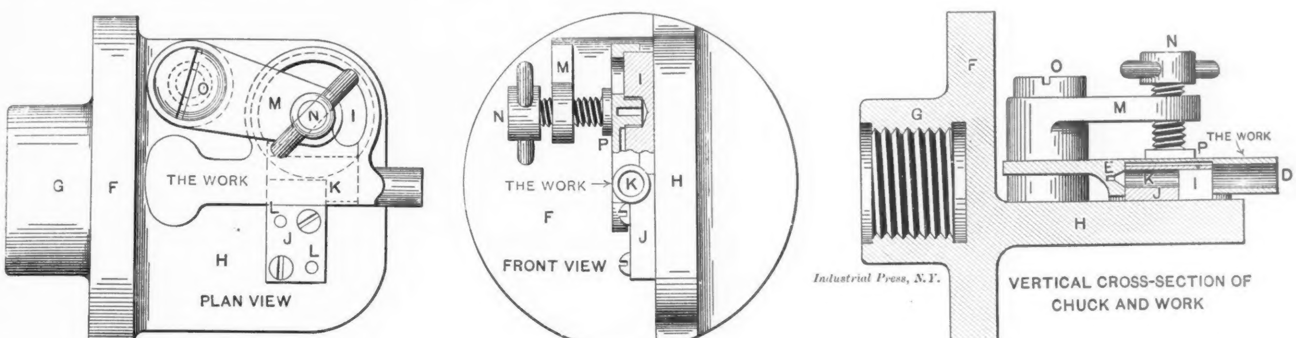


Fig. 3. Three Views of Chuck for Second Operation.

bottom *B*, and of the hub around which the dials revolve, and the drilling of the small hole *C* in the center of this hub. All this was accomplished in one operation, after the work had been fastened in the chuck, Fig. 2. The second operation was the boring and reaming of a hole *D*, Fig. 1, for the spindle

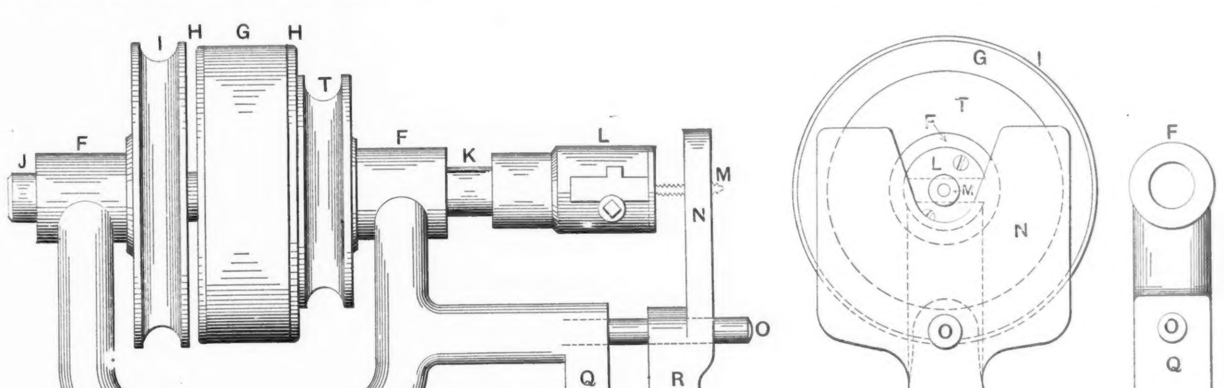


Fig. 4. Small Tapping Machine.

of the indicator and the finishing of a center end thrust bearing for the end of it at *E*. Both chucks are to be used in the screw machine in conjunction with a set of turret tools for each.

Fig. 2 shows the chuck used for the first operation and consists of a circular casting having a hub at the back and a raised portion on its face for holding the work. The casting is fitted to the screw machine spindle, and faced and bored to admit the large circular portion of the work as shown at *I*, being bored to a depth sufficient for the upper side of the work to project slightly above the face *H* of the chuck. The face of the chuck is milled away on each side of the square central portion *H*, so that the work may be easily located or removed. *J* is a flat machine steel plate, located on the face of the chuck by two dowel pins, *K K*, and fastened by the four corner screws *L L L L*. This plate, while fastened to the main casting, is bored sufficiently to tightly clamp the edges of the large circular portion and for clearance for the cutting tools. Fig. 2 shows clearly how the work is located and clamped on the chuck. The work is machined by the usual type of turret tools.

The second operation is accomplished by the use of the chuck shown in Fig. 3, which is of distinctly different design from that of the chuck, Fig. 2. It is a circular hub backed casting, with a rather long, flat, projecting standard at *H*, fitted, as in the other case, to the screw machine spindle and having the face of *H* machined flat and square with the face of *F*. The work is located on this projecting face at two points by *K* and *J*; also at *I* by a circular machine steel disk fitting within the portion *A*, Fig. 1, of the work and fastened to the face *H*, Fig. 3, of the chuck by screws and dowel pins (not

shown) and at *K* by the steel plate *J*, which, as will be seen, is fastened by screws and dowel pins. For clamping the work to the chuck the swinging bracket and clamping screw *N* are used, whose construction are clearly shown in the vertical cross-sectional view of Fig. 3, where the work is shown fastened upon the chuck. The work machined in these chucks is, needless to say, perfectly interchangeable.

Fig. 4 shows a small tapping machine which is compact, substantial and simple to operate and which was used for the rapid tapping of the small hole *C* in the work, Fig. 1. The main casting has a round flat base to be fastened to the bench and a bearing *F* at either end for the spindle *K*, on which is placed a wood friction pulley *G*, which has a leather face *H H* at each side. Two loose pulleys *I* and *T* are run at right and left of the friction pulley by means of circular belting from a small special countershaft, and between these loose pulleys and pulley *G* there is a space of about 3-32 inch. The end *K* of the spindle is turned taper for the chuck *L*. A sliding bracket *N*, having an opening in its face as clearance for the tap and for the small projecting surfaces of the work, squares and supports the work while the machine is in operation. The bracket slides easily back and forth on the stud *O*. which is driven into a hole drilled in the front extension of the main casting, and by the larger stud *P*, driven into the bracket at R and which slides into a semi-circular groove in the extension at *Q*.

When tapping work, the work is held against sliding bracket *N*, which is slid up against the tap. As the work encounters this tap the friction pulley *G* is forced against loose pulley *I* with just enough force to drive it and tap the hole. When the tap bottoms, a slight pull backward brings pulley *G* against the backing pulley *T* and the tap is withdrawn. Holes up to ¼ inch can be rapidly tapped by this machine and the tendency of the tap to break off is eliminated as far as is possible, as just enough friction is exerted to drive the machine and tap the hole.

* * *

Captain John Lawson, who assisted in the building of the first locomotive constructed under the direction of George Stephenson, died at St. Louis, Mo., November 21. He was born in Manchester, England, August 8, 1805, and when still a boy was apprenticed to Stephenson. He was a locomotive engineer for many years on different railways in the United States, but finally abandoned railroading for the steamboat business on the Cumberland River, following which he accumulated a fortune. Mr. Lawson had seen during his lifetime the inception and development of the railway, which is now one of the chief factors in the commerce of all civilized countries.

TRACKS FOR TRAVELING CRANES.

K. B.

Every up-to-date foundry and machine shop should have, among its other equipments, one or several electric overhead traveling cranes. As is well known, these cranes consist of a trolley carrying the hoisting mechanism, which has an easily controlled motion on a pair of steel girders, forming a bridge that spans the width of the building and travels on a track or runway extending over the whole length of the building, so that nearly every part of the floor area may be reached by the crane hook. The tracks are usually laid on steel girders, carried on brackets or posts riveted to the building columns—assuming that the building is made of steel framework.

In providing for traveling cranes in a building it is not only necessary that the columns and girders carrying the cranes shall be made strong enough to carry the superimposed load of crane and greatest weight lifted, but that a liberal allowance be made for vibration and shock. When a crane weighing, say, about 35 tons, and carrying a load of 25 tons, travels with a speed of more than 200 feet per minute, the momentum produced if the crane is brought to a sudden stop will cause considerable strains in the building. The building columns must, therefore, be well braced, the crane girders must have great lateral stiffness, and the tracks must be firmly secured to the girders. This latter is, however, a detail that does not always receive the attention it requires. No engine or other machinery will run well on a loose foundation, nor can a traveling crane be kept in good running order on an insecure track.

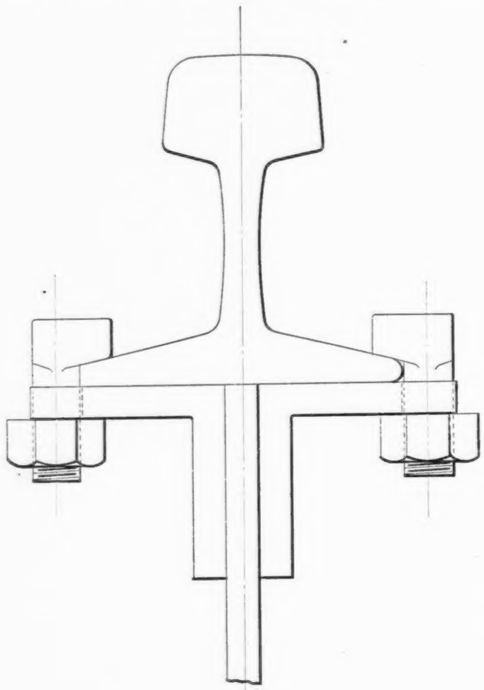


Fig. 1. Faulty Construction.

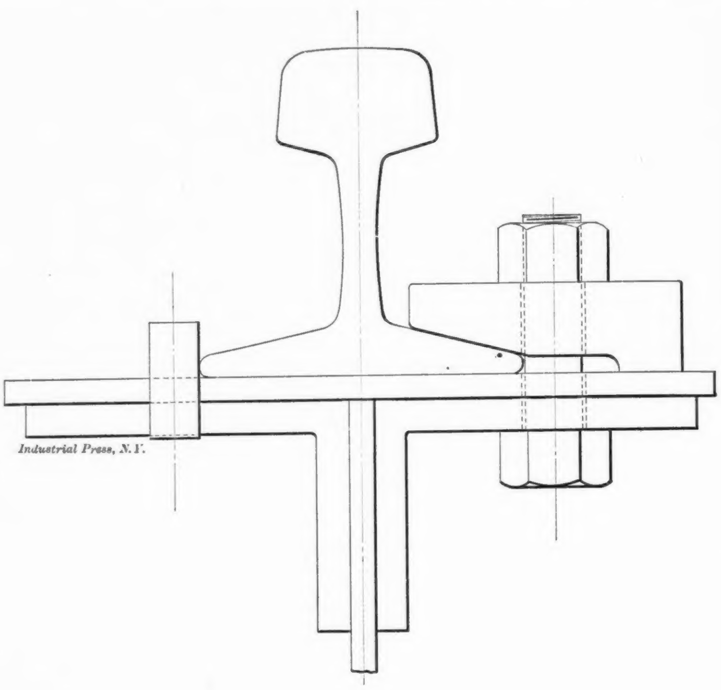


Fig. 2. Improved Construction.

The writer once had occasion to examine a crane runway in a steel mill, where a number of cranes for handling steel ingots at the heating furnaces had been in constant service for several years, with the exception of Sundays. These crane girders were made up of a web plate and four small angles, and were, no doubt, strong enough for static conditions, but did not have sufficient lateral stiffness. There was, therefore, a considerable side deflection in evidence when the cranes were running. Fig. 1, showing a section of part of the girder with the rail in position, is here given as an illustration of how the track should *not* be made. In this case the rails were held down by means of ¾-inch hook bolts which, as the girder was not much wider than the base of the rail, were placed near the edge, thus affording very little hold for the nut on the underside. The vibration had caused many of these nuts to work loose and the bolts to turn the hook side away from the rail. Consequently the rails were loose and seemed very

near being carried off the girder with every movement of the rapidly operated cranes. The flanges of the truck wheels were badly worn, and the rails were worn unevenly. It is obvious that such an uneven, imperfect track, causing the crane to skew and bind, cannot but have an injurious effect on the mechanism of the crane. It is remarkable that while repairs were continuously made to these cranes, no attention was paid to the unsatisfactory condition of the track.

A method of holding down rails for crane runways which, in the writer's experience, has proved very satisfactory, is shown in Fig. 2. For tracks ordinary steel rails of about 70 pounds' weight per yard are mostly employed. The rails are secured to the girder by means of ⅞-inch bolts and cast-iron clamps 3 inches wide. As a properly designed crane girder should have wide angles and cover plate at least in the top flange there is usually room for this clamp with the bolt in the center. In addition to these clamps ¾-inch steel dowel pins are driven into the girders close to the edge of the rails, the holes for these pins being drilled after the rails have been properly set and clamped. The clamps will hold the rails firmly to the girder and the dowel pins serve as a safeguard to prevent any side slipping of the rails. Fig. 3 is a plan view showing the proper spacing of the clamps and dowel pins.

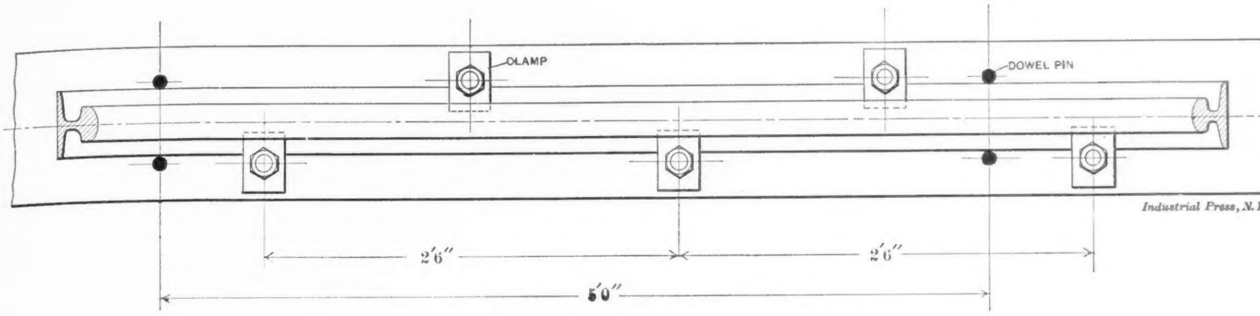


Fig. 3. Plan of Track and Girder.

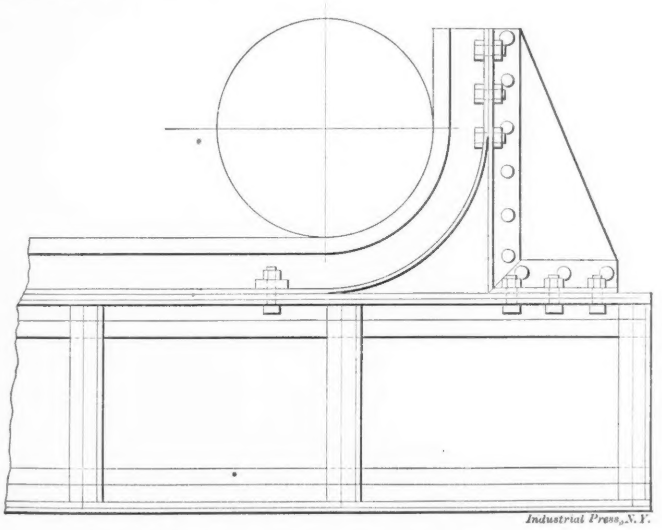


Fig. 4. Crane Stop.

Sometimes when greater stiffness in crane girders is desirable on account of large span, box girders are employed. In that case the rails have to be bolted down with tap bolts, but otherwise they are bolted down as in Fig. 2. These holes must be drilled and tapped "in the field" after the girders are erected.

Most traveling cranes are provided with brakes, not only for the absolute control of the suspended load but also for checking the speed of the trolley or the bridge, and for gently bringing the crane to rest. The brakes are either automatic magnetic brakes, operated by a pair of solenoids, or mechanical hand- or foot-power brakes. Sometimes both kinds of brakes are used on the same crane. But as an additional safeguard there should be stops provided on the track, and for this purpose there is either a cast-iron shoe bolted to the rail or the end of the rail is bent up. Neither of these stops is altogether safe, however. If the crane, through failure of the brakes to work in time or through the operator's carelessness, should approach the stops under great speed it may ride over the cast-iron shoe or the curved rail end, violently struck, may snap off. The latter case once came under the writer's observation.

A good stop is shown in Fig. 4. It consists of a riveted steel bracket which is bolted to the girder, the end of the rail being curved to a radius to conform to the wheel and being bolted to the bracket.

If the trolley stands near the end of the bridge, and the latter is set in motion, there is danger of its being run against and damaged by the knee braces for roof trusses in the building. To prevent this the stops illustrated should be placed on the bridge also, and at such a point as to keep the trolley at all times clear of any obstructions.

* * *

PROPORTIONS FOR COLLARS.

GEO. W. CHILDS.

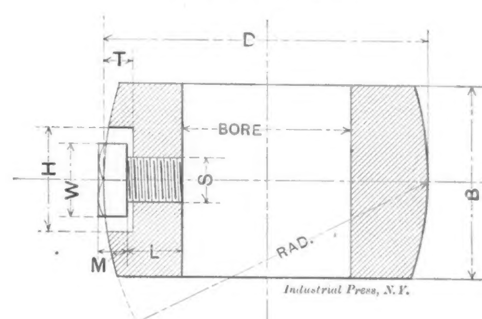


Table of Dimensions.

BORE.	B	D	H	L	M	S	T	W
$1\frac{7}{16}$	$1\frac{5}{8}$	$2\frac{3}{4}$	$\frac{7}{8}$	$\frac{17}{32}$	$\frac{3}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{5}{8}$
$1\frac{9}{16}$	$1\frac{3}{4}$	3	$\frac{7}{8}$	$\frac{19}{32}$	$\frac{3}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{5}{8}$
$1\frac{11}{16}$	$1\frac{7}{8}$	$3\frac{1}{4}$	1	$\frac{19}{32}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{5}{16}$	$\frac{3}{4}$
$1\frac{15}{16}$	2	$3\frac{5}{8}$	$1\frac{1}{4}$	$\frac{19}{32}$	$\frac{5}{16}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{15}{16}$
$2\frac{3}{16}$	$2\frac{1}{8}$	4	$1\frac{1}{4}$	$\frac{21}{32}$	$\frac{5}{16}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{15}{16}$
$2\frac{7}{16}$	$2\frac{1}{4}$	$4\frac{3}{8}$	$1\frac{1}{4}$	$\frac{23}{32}$	$\frac{5}{16}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{15}{16}$
$2\frac{11}{16}$	$2\frac{1}{2}$	$4\frac{3}{4}$	$1\frac{1}{2}$	$\frac{23}{32}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{7}{16}$	$1\frac{1}{8}$
$2\frac{15}{16}$	$2\frac{5}{8}$	$5\frac{1}{4}$	$1\frac{1}{2}$	$\frac{27}{32}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{7}{16}$	$1\frac{1}{8}$
$3\frac{3}{16}$	$2\frac{3}{4}$	$5\frac{3}{4}$	$1\frac{1}{2}$	1	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{7}{16}$	$1\frac{1}{8}$
$3\frac{7}{16}$	$2\frac{7}{8}$	$6\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{1}{16}$	$\frac{7}{16}$	$\frac{7}{8}$	$\frac{1}{2}$	$1\frac{5}{16}$
$3\frac{11}{16}$	3	$6\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{3}{16}$	$\frac{7}{16}$	$\frac{7}{8}$	$\frac{1}{2}$	$1\frac{5}{16}$
$3\frac{15}{16}$	$3\frac{1}{8}$	$7\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{5}{16}$	$\frac{7}{16}$	$\frac{7}{8}$	$\frac{1}{2}$	$1\frac{5}{16}$
$4\frac{3}{16}$	$3\frac{1}{4}$	$7\frac{3}{4}$	2	$1\frac{7}{16}$	$\frac{1}{2}$	1	$\frac{9}{16}$	$1\frac{1}{2}$
$4\frac{7}{16}$	$3\frac{3}{8}$	$8\frac{1}{4}$	2	$1\frac{1}{2}$	$\frac{1}{2}$	1	$\frac{9}{16}$	$1\frac{1}{2}$
$4\frac{15}{16}$	$3\frac{5}{8}$	$8\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{9}{16}$	$1\frac{1}{8}$	$\frac{9}{16}$	$1\frac{5}{8}$
$5\frac{7}{16}$	$3\frac{7}{8}$	$9\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{9}{16}$	$1\frac{1}{8}$	$\frac{9}{16}$	$1\frac{5}{8}$
$5\frac{15}{16}$	$4\frac{1}{8}$	$9\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{9}{16}$	$1\frac{1}{8}$	$\frac{5}{8}$	$1\frac{5}{8}$
$6\frac{7}{16}$	$4\frac{3}{8}$	$10\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{9}{16}$	$1\frac{1}{8}$	$\frac{5}{8}$	$1\frac{5}{8}$
$6\frac{15}{16}$	$4\frac{5}{8}$	$10\frac{3}{4}$	$2\frac{1}{2}$	$1\frac{7}{16}$	$\frac{5}{8}$	$1\frac{1}{4}$	$\frac{11}{16}$	$1\frac{3}{4}$
$7\frac{7}{16}$	$4\frac{7}{8}$	$11\frac{1}{4}$	$2\frac{1}{2}$	$1\frac{7}{16}$	$\frac{5}{8}$	$1\frac{1}{4}$	$\frac{11}{16}$	$1\frac{3}{4}$

* * *

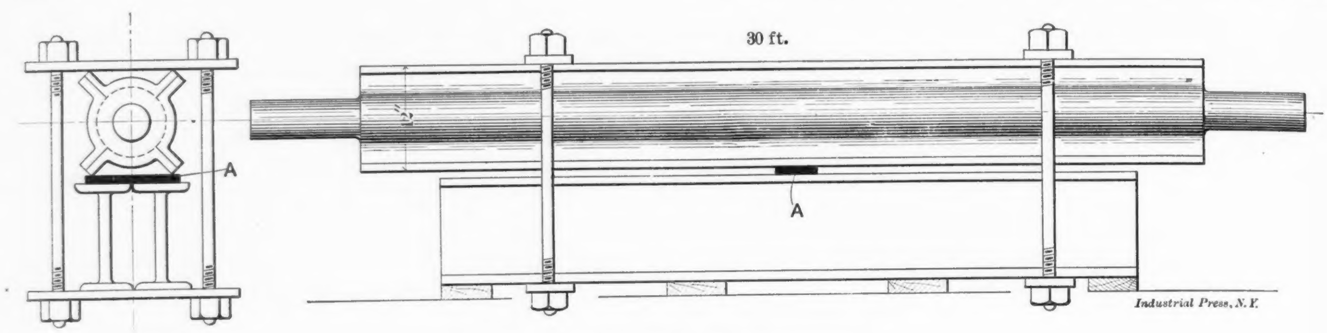
Reports of the discovery of a wonderful steel come from Berlin, Germany. A German, Herr Sieblen Giebler, is reputed to have discovered a steel which hardens like tool steel and which may be used for tools. Its alleged remarkable qualities, however, are that it is 140 per cent stronger and 50 per cent lighter than Krupp, Harvey and Bohler steel and costs one-third less.

LETTERS UPON PRACTICAL SUBJECTS.

STRAIGHTENING A THIRTY-FOOT SHAFT.

Editor MACHINERY:

The illustration shows clearly the method recently pursued in straightening a large, built-up shaft that had been badly bent by passing through a fire. The shaft was built up of channel irons, weighed 1,800 pounds and ran at a speed of 150 revolutions per minute. It was first attempted to straighten the shaft by supporting the journals in bearings, and then building a fire under it, and when the shaft was hot, to straighten it by means of a long lever, as railroad rail. It did not take long to demonstrate that this was an almost impossible task; in fact, the shaft would not retain its shape while cooling.



Straightening a Shaft of Peculiar Construction.

The next move was to take two 15-inch I-beams, which, by chance, happened to be at hand, level them up solidly on some pieces of plank and then strap the shaft to the I-beams, as shown in the illustration. The high place in the shaft was turned toward the I-beams and a distance piece about one inch high was placed between the shaft and I-beams, the two ends of the shaft being then sprung down to the I-beams by means of heavy clamps, as shown. The shaft was allowed to remain in this position four or five hours, when the clamps were removed and the next high spot was treated in a similar manner. The shaft was straightened cold and at the end of three days was perfectly true.

Had the shaft not been a spare shaft, the work might have been hastened by building a little wood fire on the shaft over block *A*, after it had been drawn down by the clamps, then heating a small part of the shaft, withdrawing the fire and cooling off the shaft quickly and slacking up on the clamps. This was not necessary, however, and is only offered as a suggestion.

The cost of doing the work was slight; it took one blacksmith and helper only a few minutes two or three times a day to do the work, and as a new shaft would have cost $250 it was evidently a paying investment. A. H. ELDREDGE.

So. St. Joseph, Mo.

* * *

RECOLLECTIONS OF A COUNTRY JOB SHOP.

Editor MACHINERY:

I had worked in the shop about a year when a new man came in to work. Now, it was not often that we put on a new hand, as the old ones seldom used to leave, and business remained about the same week in and week out, only that during a part of the year we had to put in a good deal of overtime on sawmill repairs.

Well, this new man was just over, and although he was nobody's fool, he was as green as grass. The Old Man gave him a job of turning up some short bolts and threading them. He commenced all right, centered and drilled them and then started for a lathe. Now, we had a lathe in the shop that you don't meet with nowadays, and it is just as well that you don't. It was an old style chain feed, with a handwheel for moving the carriage up at the head end, and the only way one could square up a piece of work was by continually knocking against the side of the rest so as to jar it along. The new man got his work in all right, but he could not find any way to move the carriage; so he braced his foot against the tailstock and moved it by main force. Then he went off to get a tool, but while he was gone one of the boys locked the feed so that the carriage would not move. When he came back with his tool, he tried the same trick, but it would not budge a mite. What did he do? Why, he left it just where it was, put in his work and with a couple of hand tools turned up those bolts and chased the thread on them. He did a good job and was not long about it, either, and if I had not seen it done, I would not have believed it possible to do it in that manner.

A few days after this I was running the planer when he came along with a steel key, off of which he wanted to take ¼ inch. He saw that I was busy on a long job, and he said: "Oh! never mind; I'll chip him," and "chip him" he did. It was a tool steel key, 1 by 5 inches, and he put it into the vise, took one of those wide, fan-shaped chisels and took off that ¼ inch nearly as quickly as it could have been planed. It gave me an insight as to what could be done with a chisel if one only knew how, and it gave me a respect for the man also.

When the new man had been there a week or more, the Old Man gave him a good job to do and a good lathe to do it in. It was a couple of small crankpins for a sawmill engine. Well, he roughed them out, took a light finishing cut all over them with the lathe in gear, then asked the Old Man to look at them. "They are all right; take out the back gears and polish them up," and with that the Old Man went off to look at a job that had just come in. When he got round to "Greeney" again he found that the latter had pulled the headstock apart, taken out the back gears and was polishing them up. Now, the Old Man was a church member, and so could not do justice to his feelings as he would have liked to, but by the way "Greeney" looked when his employer got through with him there was no doubt but that he understood what was wanted.

One day a team drew up with a shaft on it that was over ten feet longer than the long lathe. It was a sawmill job; one of those old, square shafts with bearings turned in it where the boxes came. The mill man was on the team, and he wanted an extra bearing three feet from the end. Here was a sticker. We could not put a center rest on it for we had no "cathead" to fit it. The Old Man measured it, chewed a straw awhile, and said, "Dump it out, you can have it to-morrow night," and went home. Next morning, bright and early, he was down with a leveler's compass and a rip saw. The long lathe stood at the end of the shop, and there was a hole in the wall that we had made to run a shaft out of. Outside the shop, about ten feet away, was a big apple tree. The boss drew a line level with the worms of the lathe, sawed off the tree at the line and bolted the tailstock on the stump, put in the shaft and turned in the extra bearing. The whole job took two men 7½ hours, and it all went in the bill, and the mill man paid it, too. I never knew whether the stump was inventoried as a tool or real estate.

Take it all in all, the boss was all right; he paid as good wages as any of the town shops, and double time for overtime (and charged it in the bill, too), and never would let a stroke of work be done Sunday, "not if he knew it." Sometimes we did a little when we were out on a job, but it never went on the bill, or the payroll, either. He used to take us

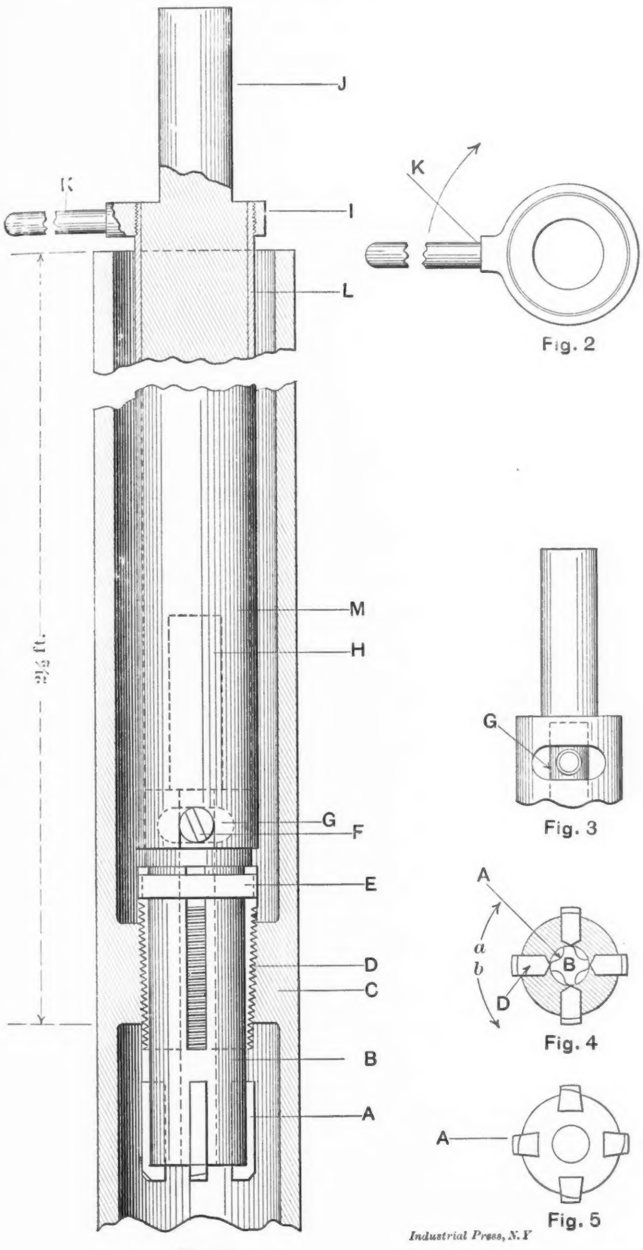
boys for a sail up the river about once a year, and also let us help get in the hay on the farm when haying time came and work was slack in the shop. When I was out of my time he got me a place as engineer in a large straw manufactory, gave me a copy of "Chordal's Letters" (a better gift to an apprentice boy it would be hard to find) and a lot of good advice. My wanderings since leaving the old shop have covered a good deal of territory, but my mind often goes back to that little country shop and the ways and means we had to use to get out the jobs. A. P. PRESS.

* * *

ADJUSTABLE SPECIAL TAP.

Editor MACHINERY:

The sketch herewith illustrates a very convenient form of collapsible tap intended to tap out holes located in out-of-the-way places, such as shown at *C*, Fig. 1. The hole shown here is located in the center of an iron column, 2½ feet from the opening in the end, and is therefore hidden from the eye of the operator. As will be seen by the sketch, the body *B* of the tap, Fig. 1, is provided with boring tools shown at *A*, whose duty consists in preceding the tap through the hole to be tapped and sizing the same for the reception of the tap proper. When the cutters *A*, Fig. 1, have passed through the hole the operator simply continues to feed the drill spindle (to which the shank *J* is attached) downward until the threaders *D* engage the bored hole and tap it. After the thread is cut the operator pulls the handle *K* in the direction of the arrow, Fig. 2, which causes the threaders to close in and the tap can be withdrawn without the usual backing out.



Details of Tap.

The handle *K* is attached to a wrought-iron ring screwed and riveted on a piece of gas pipe *L*, Fig. 1, which encases the main shank *M* into which the shank *H* of the tap proper is fitted. This shank is slotted, as shown in Fig. 3, to allow a screw *F*, Fig. 1, to connect the outer pipe with a shaft *G*, Fig. 3, and also to permit the latter to rotate when handle *K* is operated. The lower end of shaft *G* is fluted to form four cam surfaces, as shown at *B* in Fig. 4, which bear against the threaders *D*.

By pulling the handle, as before mentioned, shaft *B*, Fig. 4, is turned a quarter turn and threaders *D* are forced into the milled grooves *A*, Fig. 4, by the spring band *E*, Fig. 1, when the tap can be withdrawn.

The features of the tap are the combined boring tool and tap and the doing away with backing out the tap.

Brooklyn, N. Y. GEORGE J. WINKLE.

* * *

A POINTER ON HARDENING TOOLS, ETC.

Editor MACHINERY:

It is a known fact that in order to get the best results from quenching tool steel in a strong brine it is necessary to have the steel at the lowest heat at which it will harden. I have found out by experience that steel will harden at a much lower heat in a strong brine—say 20 pounds of rock salt to 50 gallons of rain water, thoroughly dissolved.

Now to come to the point, we all know that an easy way to harden tools is by quenching only the point or end of the tool for about one or two inches, then brightening same with emery cloth and letting the color "run." My method of doing this is to get the steel heated very slowly to the lowest possible red at which I think it will harden, then to quench it in the usual way, having previously placed a small smooth flat file at hand, and before the color has a chance to "run" to try the steel for hardness with the file. If it proves hard, brighten it and watch the color; if soft, immediately place it back in the fire and in very short order you can get it up to a little higher heat than previously and then go through the same routine. I find I am generally successful the second time and am sure of a good temper without having wasted much time. HARRY ASH.

Chicago, Ill.

* * *

METHOD OF GRADUATING ANY SPECIAL SHRINK RULE BY HAND WORK.

Editor MACHINERY:

Pattern makers and others often wish to obtain some special shrink rule not on sale or usually made. The sketches herewith show that by care a judicious workman may construct, by hand-graduating, any special rule he wishes to possess.

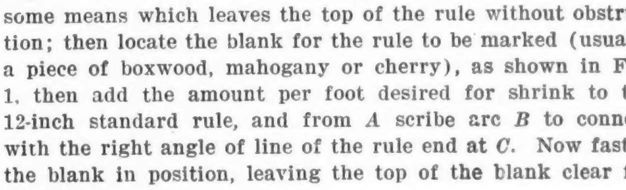


Fig. 1.

Fig. 1 shows a U. S. standard rule as the guide to a spacing shrink rule; fasten this standard rule to a board by some means which leaves the top of the rule without obstruction; then locate the blank for the rule to be marked (usually a piece of boxwood, mahogany or cherry), as shown in Fig. 1, then add the amount per foot desired for shrink to the 12-inch standard rule, and from *A* scribe arc *B* to connect with the right angle of line of the rule end at *C*. Now fasten the blank in position, leaving the top of the blank clear for marking.

Having located and secured the standard rule and blank in proper position, the next thing is to get out a marking gage, as shown in Fig. 2, at *F*. Make this gage of thin sheet steel, turning down at *O* as a guide for the gage. The correctness of the marking of the blank will depend on three or four items:

Correctness of the standard rule; correctness of location of the blank; uniformity of setting the gage at *X*, and mark of the line at *T*. Care must be taken that the line cutting tool be not thick and blunt, and that it be held the same way each time a line is cut. The writer has used for this purpose a special tool which is always guided alike at each marking; that is, in an upright position. A good expert workman can, even by hand, thus produce a shrink rule which will make

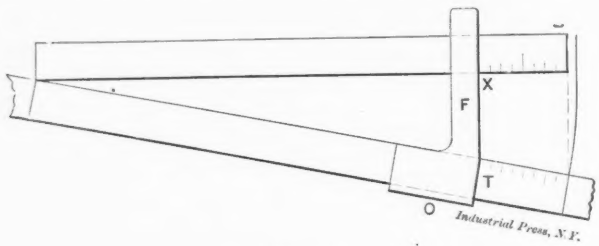


Fig. 2.

some of the cheap wood rules blush. I have a sample of one of these cheap "wiggle" line rules in my possession at the present time. This graduating machine is not a costly affair, and it can get any special rule you want if you handle it right.

When marking, cut light lines at *e e*, and then cut off the blank at these lines.

F. W. Clough.

Springfield, Mass.

* * *

ANOTHER METHOD OF FINISHING THIN RINGS

Editor Machinery:

In both August and October Machinery I find that some of your readers have had trouble in finishing thin cast-iron rings parallel on both sides. The method here described is simple and very satisfactory for making piston rings or other rings of a similar nature. I have nearly always made these rings eccentric.

I have my castings made with lugs, as described by "Nemo" in the October number, but for the small sizes, 3 and 4 inches in diameter, I find it necessary to cast the lugs on the outside of the rings in order to bolt them to the faceplate slots, as these slots do not generally come near enough to the center of the plate to allow bolting the small sizes from the inside.

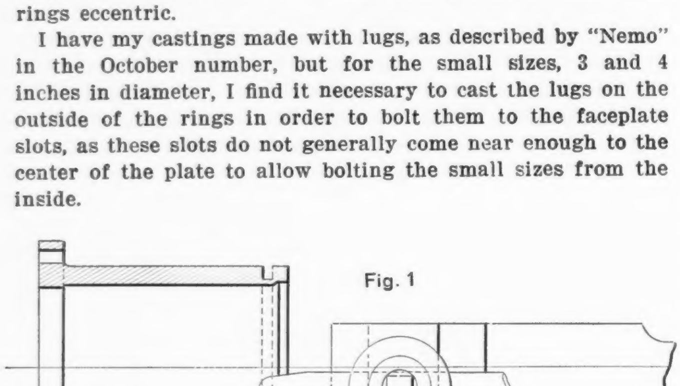


Fig. 1

Fig. 2

The first operation is to face off the bottom or lug part of the casting and bolt it to the faceplate of the lathe. Then turn it to rough sizes, both inside and out, and loosen up all of the holding bolts but one, to let the spring or strain out of the casting. Now, clamping it again, turn the outside to finished dimension. When this is done, move the casting over the faceplate a sufficient amount to give it the desired eccentricity of bore. This makes the ring elastic, or, in other words, gives it a good backbone. In sizes of rings ranging from 8 to 18 inches, I make a difference in thickness of 1-16 to ¼ inch. Now bore the inside to within about 1-16 inch of the finished size. The finishing is done with a boring tool and a cutting-off tool placed side by side in a compound rest which is set at 90 degrees. This gives two tools in readiness for use, as will be seen by reference to Fig. 1.

Now, with the cutting-off tool, make a groove in the casting a little further from the end than the finished thickness of the ring, and a little deeper than the finished diameter of the bore. With the boring tool face off the end of the ring to exact width, thus making both sides parallel; and with the same tool bore out the ring to exact size. When the groove made by the cutting-off tool is reached by the boring tool the ring will be completed.

I cut these rings as shown in Fig. 2, as I find that rings cut on the slant will break very easily when used on steam hammers, or wherever there is a heavy blow or jar. Rings cut in this way must be very accurately made, without play room at *A*. The lower half must support the upper half and have rounded corners at *B*.

A. J. D.

Neubrandenburg, Germany.

* * *

MORE TALK ABOUT CRANKS.

Editor Machinery:

I was much interested in Mr. C. W. Putnam's method of finishing cranks, published in the July number, and "Nemo's" method, described in the October number of Machinery. I would machine the crank as Mr. Putnam suggests, when I had suitable parallels, but if I had not I would machine it according to circumstances, which would take a little more time, but would not injure the quality of the job.

When the cranks are 10 inches stroke or larger I almost always find it better to finish the rim after the shaft is pressed. I do not see the necessity of so much laying off; for I have never yet seen a case where more than the following was necessary, and generally less will do:

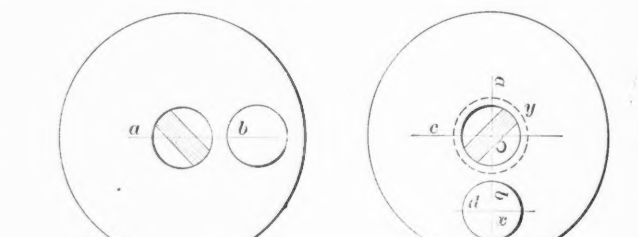


Fig. 1. Fig. 2.

Put a stick in the back of the shaft hole and on it find the center of the hole with the hermaphrodite caliper. Find the center of the pin in front in the same way. Place the crank on a flat surface, and with two or three wedges block it up so that the faces are perpendicular to the plate, and so that the two centers previously found are at the same height, as in Fig. 1. Now with a surface gage set to the same height as these centers, draw line *a* on the back of the crank and across the stick; and draw line *b* on both ends of the pin, as in Fig. 1. Next roll it over till lines *a* and *b* are square with the plate, as in Fig. 2. Draw line *c* on the back of the crank and across the stick, and line *d* on both ends of the pin. Lines *c* and *d* are drawn a distance apart equal to one-half the throw of the crank, and as close as they will come to the first centers found. Where these lines cross at *o* on the stick, and at *x* on both ends of the pin, will be the correct centers of the shaft and pin. If the stick must be removed in putting the crank in the lathe, it is well to draw circle *y* from center *o*, so that *o* can be found again, as it is much easier to true up a hole in a casting from the center than from the edge.

When the throw of the crank must be within 1-32 inch of being correct, it is best to place an arbor of some convenient size between the lathe centers and to caliper from it to the crank-pin.

The only tool I ever found better than the universal square and center head to locate a keyseat with, was a jig. "Nemo" should remember this, so that if he has another crank to lay out and has to center both ends of the pin, the moss will not be growing on it while he hunts up the parallel strips, V-blocks, straps and bolts which he told us he used. Should his crankpin be like the majority of such castings, he would have trouble enough to make the faces of the disk stand square when he tightened up the nuts.

Crank.

TESTING DUPLEX PUMP VALVE MOTIONS.

Editor MACHINERY:

It is occasionally necessary to test valve motion stands on duplex pumps, as, for instance, when traveling the pump it is found that at the end of stroke the valve moves too far, or not far enough. After inspecting the valve and other parts of the machine, and finding they are built according to drawings, our attention is naturally called to the valve motion. To avoid removing this motion from the machine, in cases where we can work trammels without interference from cradle or yoke, the following method may be used, as illustrated in Figs. 1 and 2.

First, a pair of trammels must be had which will take one of Starrett's ball attachments, as at *L*, in Fig. 1. Then, using the hole *H*, in the lever *M*, as a pivot for the ball, strike arc *A* on the short lever *N*, as shown in Fig. 2, and then, with the small ball in the dividers inserted in the center hole *O*, in the shaft for a center, strike the arcs *B B* to cut the arcs *A* at *C C*. With *C C* as centers, strike the arcs *D D D D* with equal radii, and then a line *E*, drawn through the intersections of these arcs, will be proper center line for the short lever to make it exactly parallel with the longer lever *M*. This will show how much the hole in the short lever is out of line and will thus determine exactly what is to be done to rectify the same.

C. W. PUTNAM.

Holyoke, Mass.

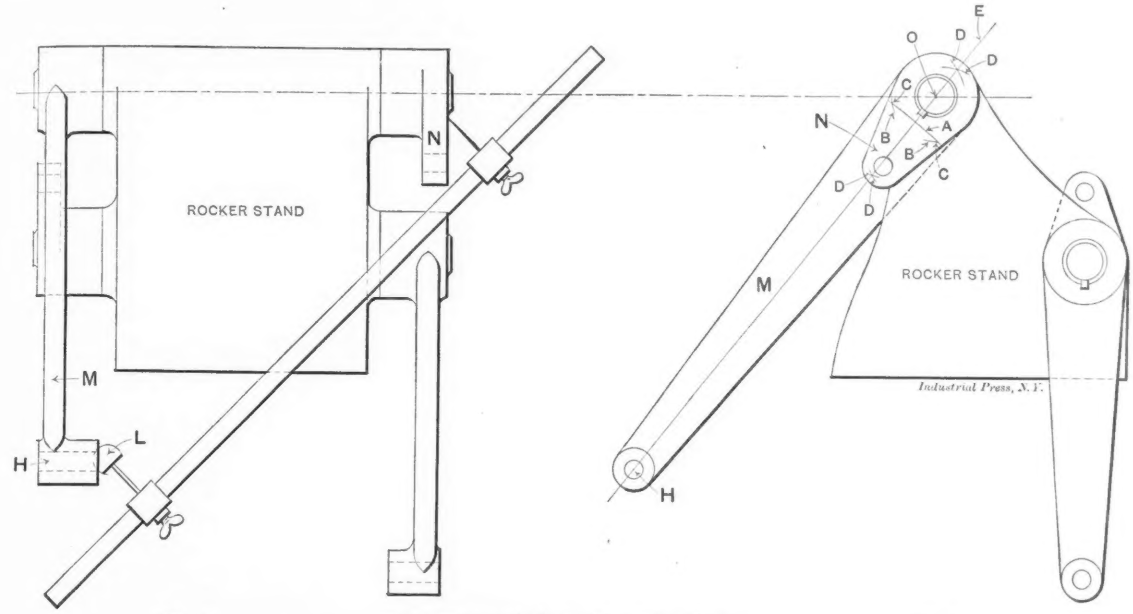
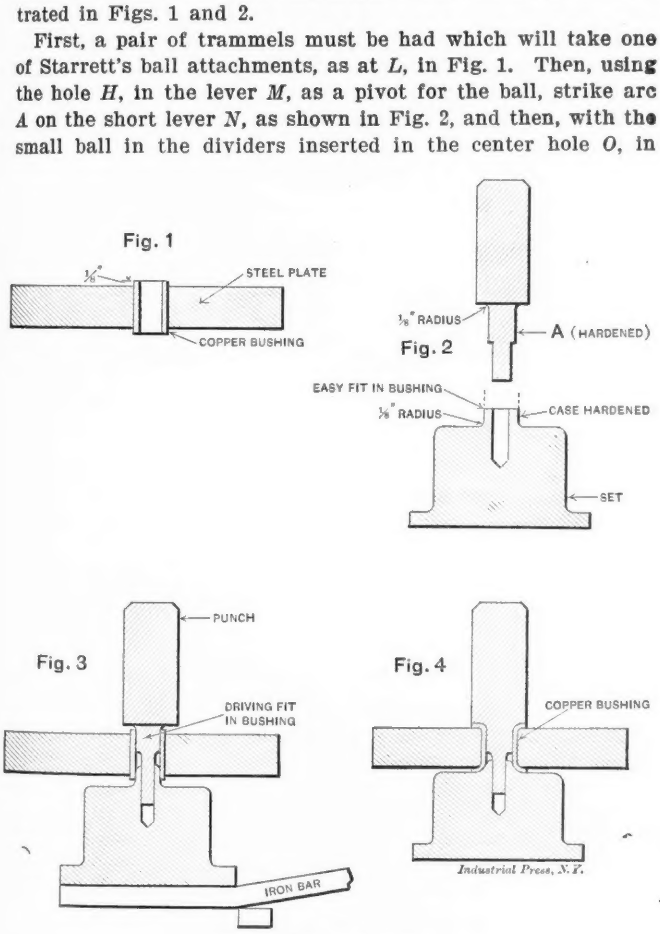


Fig. 1. Use of Trammels in Testing Valve Motion. Fig. 2.



Beading Tool and its Use.

SETTING COPPER BUSHINGS—TEMPERING.

Editor MACHINERY:

I once had occasion to fasten a number of copper bushings into ⅝-inch steel plates in order to make it possible to solder in copper wire for conducting electric current, and at the same time insure a perfect contact. The bushings were ¾ inch outside diameter and ⅝ inch inside. The plates were placed in such a position as to make it necessary to bead top and bottom in one operation. Fig. 1 shows the copper bushing in place, being simply pushed through a ¾-inch drilled hole and allowed to project ⅛ inch on each side.

The tool used consisted of a punch and block, as shown in Fig. 2.

In using, the block was supported by an iron bar, as in Fig. 3, and the punch was driven in as in Fig. 4. The punch was a tight fit in the bushing, causing the latter to spread in the hole, thus making an excellent contact. The punch may be easily removed by first withdrawing the block and then prying against the teat of the punch with an iron bar, the bushing being held in place by the beading.

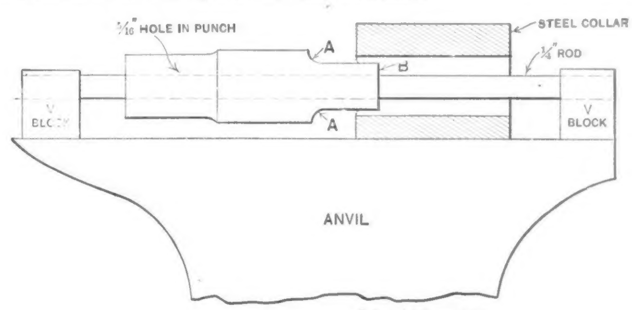


Fig. 5. Drawing Temper of Punch.

In conclusion I would say that one blow of the hammer finished this job, which was a neat one. My method of drawing the punch, after hardening same, was to brighten the turned part and teat, and while the punch was red hot, before applying the cyanide for case-hardening, I simply inserted the teat in the hole, which was 1-16 inch larger, and let the color run up, making the teat blue and part *A*, Fig. 2, light straw.

Having had considerable trouble owing to punches cracking in the hardening, notwithstanding the fact that I used the greatest care in trying to secure an even heat and used salt water bath and as low a heat as I knew would be safe, I decided to try a scheme of which I had heard previously. It is simply this: I drilled a small hole 5-16 inch through

the center of the punch—an operation which requires but little time. This is done in order to give the metal a chance to contract without the resistance which naturally takes place when there is no clearance for such contraction. Generally the presence of such a hole does not impair the efficiency of the punch. Since trying this scheme I have had no trouble resulting from cracked punches and do not expect that I ever will.

The sketch, Fig. 5, illustrates my method of drawing a punch, which had to be as hard as possible at the forming parts *A A*, and dark straw near the cutting portion *B* to stand punching and forming square holes in ⅝-inch machine steel, the top corners of which had to be rounded. I had two collars for heating, thus allowing one to be in the fire while using the other. Each collar had a flat which prevented its rolling off the anvil, and these two collars, used alternately, did the work in an entirely satisfactory manner.

ROBT. A. LACHMANN.

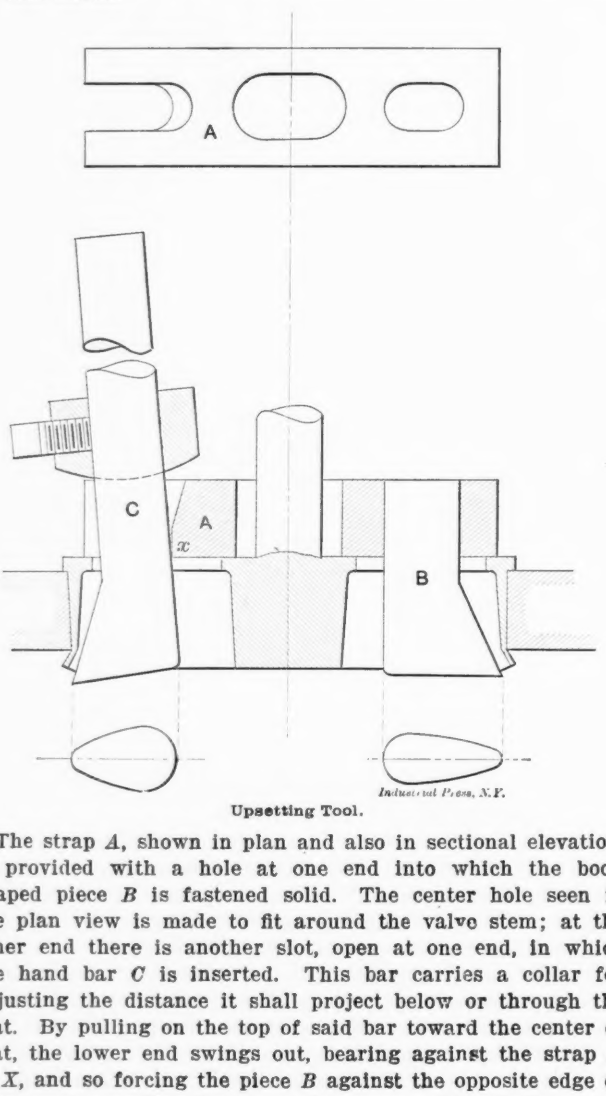
Chicago, Ill.

* * *

UPSETTING WATER VALVE SEATS.

Editor MACHINERY:

Enclosed you will find blueprint of a very useful device for upsetting the bottom edges of water valve seats, thus preventing them from working loose when once driven in. The seats should be made long enough so as to project through the casting about ¼ inch. Reference to the accompanying illustration will show the construction and method of operation of this device.



Upsetting Tool.

The strap *A*, shown in plan and also in sectional elevation, is provided with a hole at one end into which the boot-shaped piece *B* is fastened solid. The center hole seen in the plan view is made to fit around the valve stem; at the other end there is another slot, open at one end, in which the hand bar *C* is inserted. This bar carries a collar for adjusting the distance it shall project below or through the seat. By pulling on the top of said bar toward the center of seat, the lower end swings out, bearing against the strap *A* at *X*, and so forcing the piece *B* against the opposite edge of valve seat, crowding it out, as shown.

WM. F. TORREY.

Quincy, Ill.

* * *

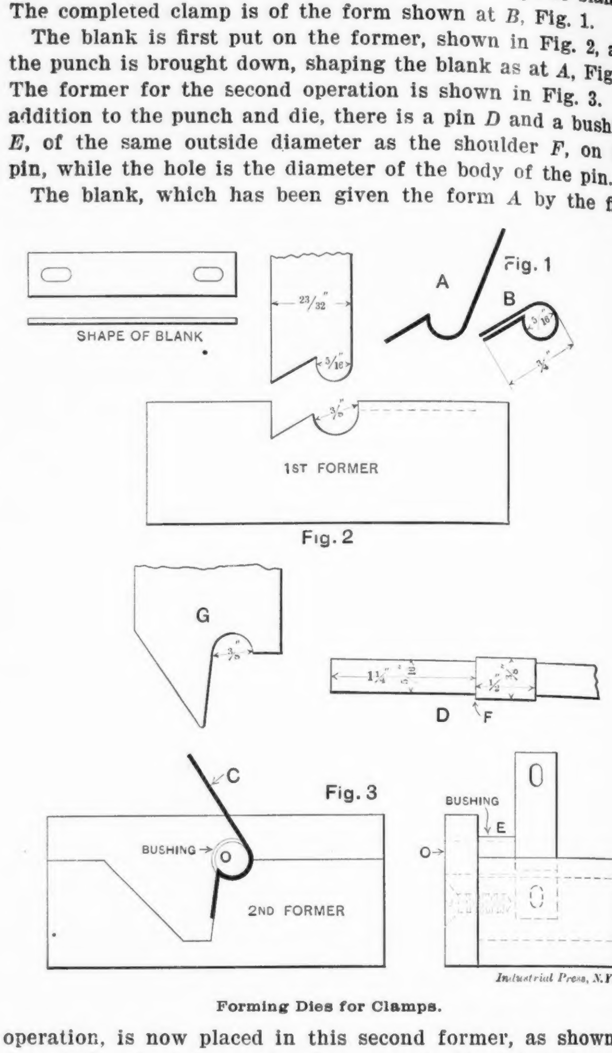
DIES FOR FORMING BINDING CLAMPS.

Editor MACHINERY:

I send you a sketch of a pair of forming dies which I think will be of interest. They are for forming binding clamps from punched blanks marked in the sketch "shape of blank." The completed clamp is of the form shown at *B*, Fig. 1.

The blank is first put on the former, shown in Fig. 2, and the punch is brought down, shaping the blank as at *A*, Fig. 1. The former for the second operation is shown in Fig. 3. In addition to the punch and die, there is a pin *D* and a bushing *E*, of the same outside diameter as the shoulder *F*, on the pin, while the hole is the diameter of the body of the pin.

The blank, which has been given the form *A* by the first



Forming Dies for Clamps.

operation, is now placed in this second former, as shown at *C*, and the pin *D* is put in place with the blank held between the bushing *E* and the shoulder *F*.

When in place, the shoulder *F* of the pin pushes the blank firmly against the bushing, the end of the pin being held in place by the hole *O* in the side of the former. The punch *G* is then brought down, and the point, just catching the end of the blank, forces it down and around the pin, thus giving it its completed shape. When desired, almost a perfect circle can be bent by this method.

TOOLMAKER.

* * *

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

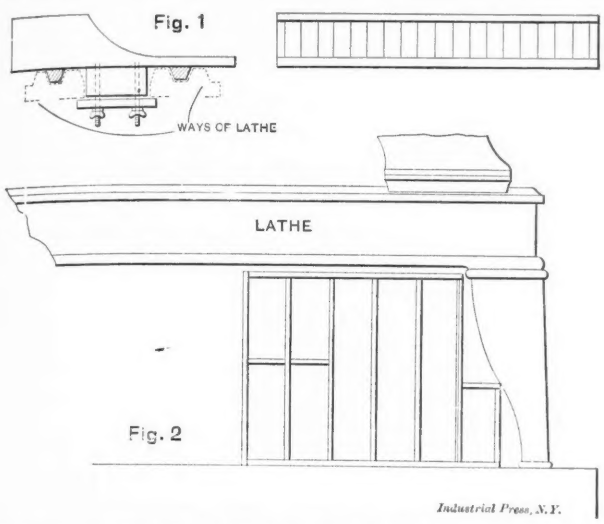
ALUMINUM KINK.

It is well known that aluminum is not readily soldered, and this peculiarity has been a great hindrance to its general use. Our contributor, James P. Hayes, however, instances a case where this peculiarity was taken advantage of in a gun shop and proved to be a positive benefit instead of a detriment. Iron wedges have heretofore been used for holding the two ribs in place between the barrels of a double-barrel shotgun while the barrels and ribs are being soldered together. The barrels are wrapped with bands of wire and the wedges driven under to tighten the bands. Great trouble has been experienced with the iron wedges being soldered to the ribs by surplus solder. Aluminum wedges were procured and have proved a success, as they will not stick to the barrels and fall off when the bands are removed. The wedges were cast from wooden patterns.

HANDY LATHE AND SHOP KINKS.

"Wabash" writes as follows: Instead of laying lathe tools on the shears or on a loose board, to be knocked down every time some one passes by, I had a board made like that shown

in the sketch, Fig. 1. This board is clamped to the lathe where the tailstock is clamped. I use a couple of wing nuts for clamping so that if the job is one that requires the whole length of the lathe, the board can be removed very easily. I divide the space between the top of the back part and the main board into spaces which admit the lathe tools. This is done by cutting, with a thin saw, a narrow groove in the boards before they are put together, and slipping in pieces of sheet iron for the partitions, which keep the tools from falling over. The shelf at the back is convenient to lay calipers, scales, etc., on, as they are apt to be injured when kept in the same place with lathe tools.



Another handy thing is a case for holding chucks, faceplate, steady rest, etc., which may also be placed under the lathe. This is better than being obliged to dig them out of the chips every time they are to be used. The case just fits under the lathe, at the tail end where there are not many chips to gather on the top of the case. Of course, on large lathes the case could not stand under the lathes but would have to be put in some other place. See Fig. 2.

I find that a small brush and a tin can with a lid to it, holding about a quart of oil, are much better to oil the ways of a lathe or planer than a squirt can; one can oil the dovetailed slides much more satisfactorily. If one desires to oil the bright parts, or calipers and other small tools, vaseline is good for the purpose. Thin the vaseline with gasoline and apply with a brush. The gasoline evaporates and leaves on the tools a thin coat of vaseline which will not turn black, as does machine oil.

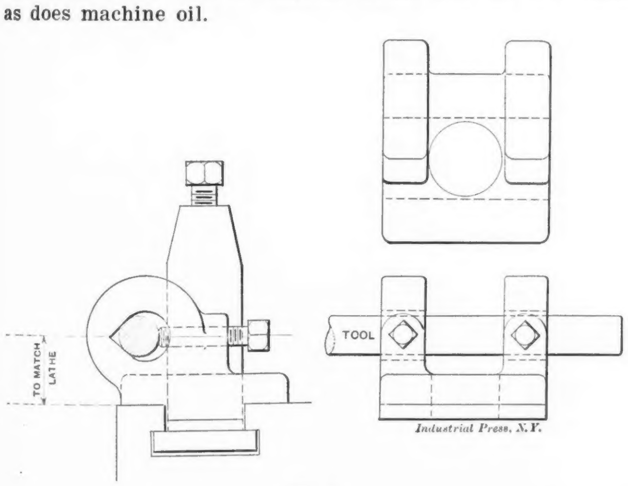


Fig. 3.

If you use lard oil when cutting threads, and soapy water for turning, put each in a different style of squirt can, or else paint the cans different colors. This applies to the whole shop. I know of a shop where they keep machine oil, lard oil and soapy water in squirt cans that are all alike, so that a man must squirt out some of the contents of the can to tell what it contains, and thus he may waste more than he uses. Or perhaps he oils (?) the spindle with soapy water and uses the lard oil for a water cut.

LATHE BORING TOOL HOLDERS.

J. B. G., Cleveland, O., writes:

The lathe boring tool holder, Fig. 3, has been in use in the shop where I am connected, and has given very good satisfaction. It is a plain iron casting, tongued and fitted to the toolpost slide of the lathe in which it is intended to be used, and is clamped in position by inserting a piece of steel in the toolpost and secured as an ordinary tool would be clamped. The boring tool is clamped by two set-screws, and the heart-shaped holes for the tool not only accommodate different sized tools, but insure rigidity.

The holder is very efficient, and yet so simple that the illustration fully explains itself.

SIMPLE LATHE RIG.

Geo. W. Strombeck, Moline, Ill., writes:

In passing through a machine shop not long ago, I noticed a little device by means of which a number of tools could be held in position for alternate use on small lathe work. The work turned out in this particular instance was a kind of

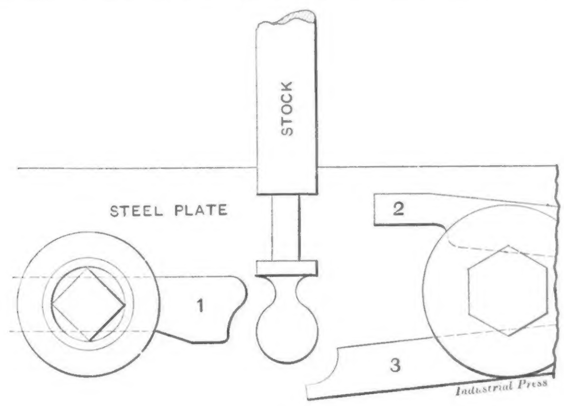


Fig. 4.

round-headed pin, adapted for stoppers in oil holes, etc., but the principle can, no doubt, be used with advantage on other small lathe work.

The accompanying illustrations, Figs. 4 and 5, are so plain as hardly to need any explanation. As can be seen, the rig is

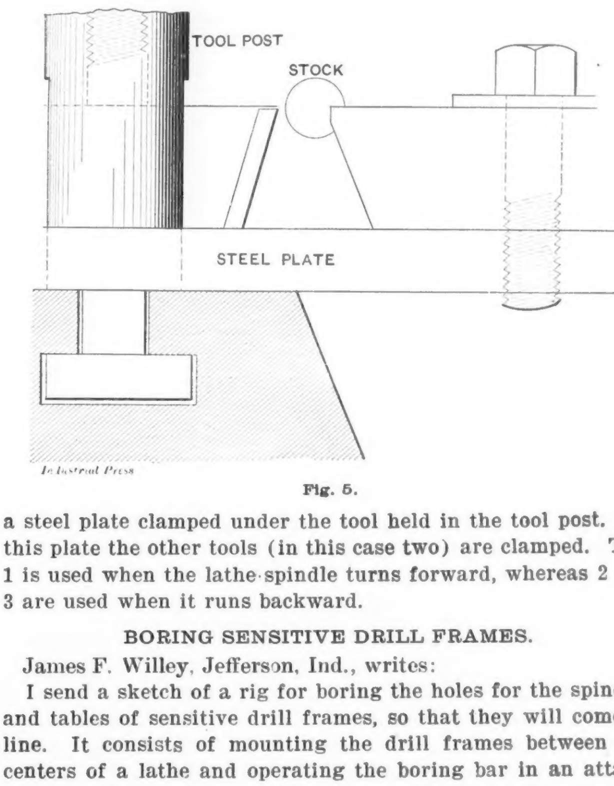


Fig. 5.

a steel plate clamped under the tool held in the tool post. On this plate the other tools (in this case two) are clamped. Tool 1 is used when the lathe spindle turns forward, whereas 2 and 3 are used when it runs backward.

BORING SENSITIVE DRILL FRAMES.

James F. Willey, Jefferson, Ind., writes:

I send a sketch of a rig for boring the holes for the spindles and tables of sensitive drill frames, so that they will come in line. It consists of mounting the drill frames between the centers of a lathe and operating the boring bar in an attachment on the carriage of the lathe, as shown in the cut, Fig. 6. The boring bar is fitted in the casting *A*, which is bolted to the carriage, and it is driven through gears at *B* by the long-splined shaft *S*. The splined shaft is carried in a bearing *C*, fastened to the headstock, and it is driven by the small pulley *P*, belted to the cone pulley, the cone pulley being out of

gear with the spindle. The drill frame is swung around until the table support D is in line with the boring bar, and then the support is bored. Then the support is loosened on the frame and swung out of the way, and the boring bar moved up to sliding head E. The head is bored, and then removed, so that the boring bar may be moved up to the top of the column for boring and facing it at H. The carriage movement is utilized for feeding the boring bar when boring. In this way perfect alignment is secured throughout.

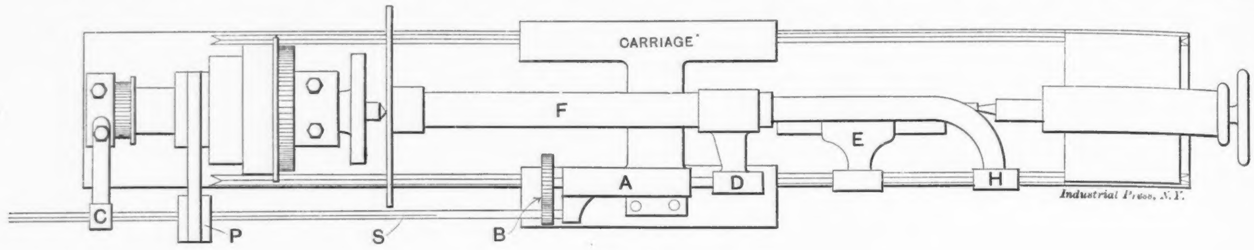


Fig. 6.

TWO METHODS OF MAKING PUNCHES.

W. L. sends the sketch herewith of two kinds of punches which he says have been used quite frequently in the punching presses in their factory and he has found by practice that the punch shown in Fig. 7 is far better than that illustrated in Fig. 8. This punch, Fig. 7, can be made from steel one-half the diameter of punch No. 2, which is quite a saving where many are to be used. It can be tempered more evenly, as the stock is more evenly cooled off in the hardening, and a variety of smaller sizes can be had by reducing the point, using the same sleeve for them all. This sleeve is tempered in oil so that it is very tough and prevents the punch from bending, whereas the other punch bends when left soft enough to prevent the point pulling off. W. L. states that they have used these punches on iron thicker in diameter than the punch, as in the case of punching holes for cold pressed nuts, and with these punches they have punched two tons of iron which work the other punch did not stand.

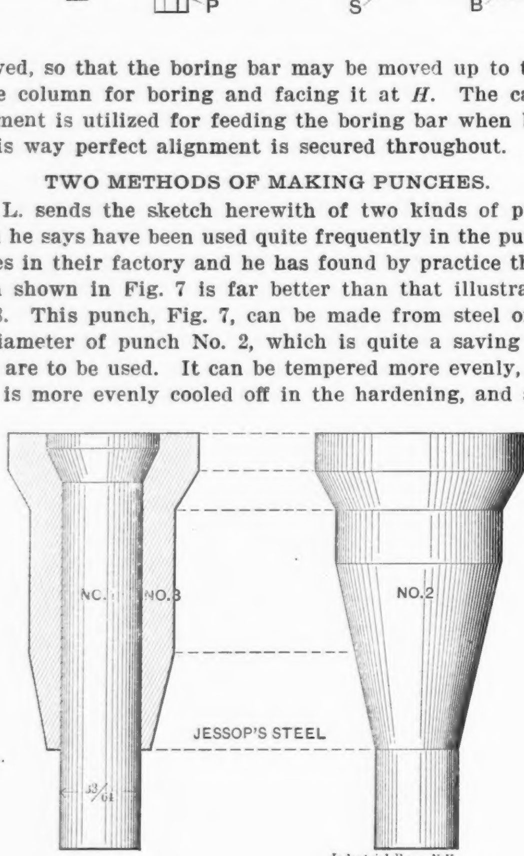


Fig. 7. Fig. 8.

WASHING OVERALLS.

"Nemo" writes: Machinists' overalls are the horror of every "washer lady" and most laundries do not fall in love with them. I once worked in a back country shop where the problem of clean overalls had been solved. In the cellar they had a machine built, as shown in Fig. 9. It consisted simply of a barrel with flanges bolted on opposite sides "amidships." These flanges were to hold short pieces of shafting, one of which was long enough to hold a pulley. The shafts were mounted in suitable bearings so the barrel could revolve, and one end of the barrel had an elliptical hole cut in it which was fitted with an ordinary boiler manhole plate and yoke about 9 x 12 inches.

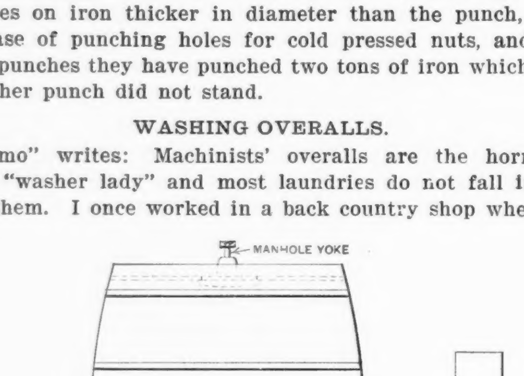


Fig. 9.

The overalls were put in through the hole with two or three pails of water, hot preferred, and a half a bar of soap or a liberal quantity of soap powder. Then the manhole plate was put in, the belt attached and the barrel was revolved at about 50 turns a minute for about two hours. The overalls were then removed and rinsed in clean water and hung up to dry. By this method the dirtiest overalls could be made as clean as when new.

BELT SHIFTER.

At the works of the Brown & Sharpe Mfg. Co., Providence, R. I., belt shifters are in general use for shifting the belts on the driving cones of the various machine tools. The sketch, Fig. 10, shows the principle of construction of the shifters as applied to an engine lathe. The vertical shifter rod has a bearing at the bottom in a bracket attached to the lathe bed, and at the top is supported by a cast-iron bracket attached to the ceiling. The top bracket is made in two pieces, the lower one of which can be swiveled upon the other for convenience in adjustment. At a point on the rod near the countershaft cone is attached a sleeve, free to turn, but not to slide on the rod, and through which slides the arm or rod carrying the belt shifter. The shifter acts on the side of the belt which approaches the pulley. In shifting the belt it must be thrown off the step on which it is running on the lower cone, with the hands, and it is changed on the upper cone, one way or the other, as desired, by the aid of the handle attached to the lower end of the vertical rod.

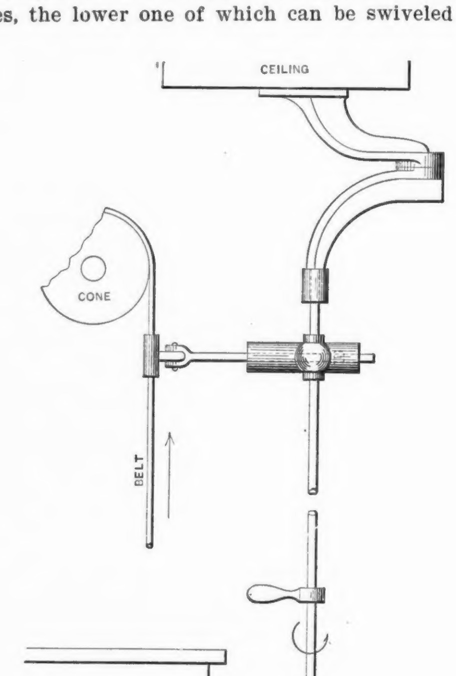


Fig. 10.

NEW TOOLS OF THE MONTH.

Under this heading are listed new machine and small tools when they are brought out. No tools or appliances are described unless they are strictly new and no descriptions are inserted for advertising considerations. Manufacturers will find it to their advantage to notify us when they bring out new products, so that they may be represented in this department.

The Phœnix Mfg. Co., Hartford, Conn., have brought out a centering machine which is designed to use a combination center drill and reamer. Reamers are furnished by the makers of the machine, with shoulders to butt against the chuck jaws and prevent slipping. A chuck and a V-block are provided for holding the work.

A new riveting machine is manufactured by Harvey Hubbell, Bridgeport, Conn., which will take work up to 3-16 inch in diameter. The spindle strikes about 900 blows per minute, the force of which can be easily adjusted to suit the conditions. The machine has an adjustable table for holding work of various dimensions, and the operation of the machine is under perfect control by means of a treadle.

A cutting-off machine of unusual size has been brought out by the Hurlbut Rogers Machine Co., of South Sudberry, Mass. It will cut off unfinished stock up to 8 inches in diameter; and as the tools approach the center, the speed of the work is accelerated upon the same plan as with other machines made by this company, in order to give a uniform cutting speed throughout the entire process of cutting off the bar.

An ingenious crankpin-turning machine is being built by the Crankpin Machine Co., 135 Broadway, New York. It is designed for turning crankpins which are forged solid with the shaft, or for turning eccentrics when they are a part of the shaft. In this machine the shaft is stationary and the tool travels about the pin. The design is such that cranks can be turned on shafts of any length, and pins can be turned on cranks of any throw within the limits of the machine. An automatic longitudinal feed is provided.

In the November MACHINERY was published a description of an electrically-driven Yankee twist drill grinder made by the Wilmarth & Morman Co., Grand Rapids, Mich. This grinder is provided with a water supply by a centrifugal pump. A machine of similar design has now been brought out by the same company, but is belt-driven instead of electrically-driven. It has a capacity of drills from 1/8 to 2 1/4 inches in diameter, and can be fitted for special work, such as for grinding the 4 to 8-lip agricultural reamers used for reaming cored holes.

MILLING MACHINE ATTACHMENT.

The cut herewith, Fig. 1, is of a die shaper attachment brought out by the Rochester Die Shaper Co., Rochester, N. Y., which can be applied to any standard milling machine for working out dies for punching presses, etc. The device clamps on the overhanging arm of the milling machine and is driven by a spindle fitting into the machine spindle. A cam fastened between the two bearings provided with this spindle operates a horizontally sliding block which works in the cross slot of a vertical slide carrying the cutting tool, which latter is secured in the socket by a setscrew. The tool socket is separate from the vertical slide, however, so that when the tool is set it may be turned as required, allowing all the corners to be worked into. A clapper block is provided for giving clearance for the tool. It will take a chip of steel of 1/8 inch by 1-32 inch, and in cast iron of 3/8 by 1-32 inch.

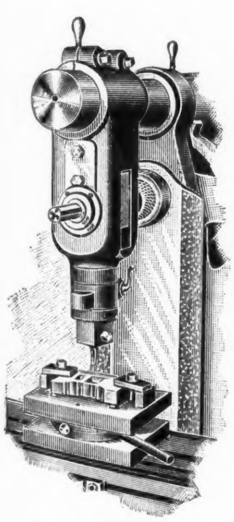


Fig. 1. Die Shaper.

The cut shows the tool at work upon a half die of irregular outline. This die is mounted upon a tilting chuck which accompanies the attachment and provides the necessary clearance angle for die work.

ATTACHMENT FOR CALIPERS.

The Walker Tool Co., 345 Pierce Street, Milwaukee, Wis., have placed on the market a useful little attachment to be used in connection with machinists' calipers. It is a swiveling clamp designed for holding either steel points or pencils. When an attachment is clamped to each leg of a pair of ordinary calipers, and steel points are inserted, it converts them into a pair of dividers. It will be noted that inasmuch as the points can be made to swivel they can always be adjusted so as to stand perfectly straight and thereby remain

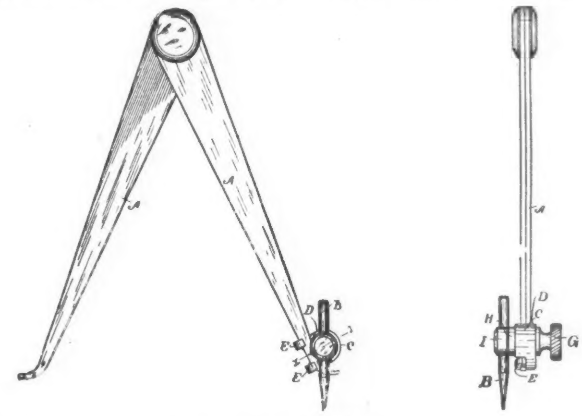


Fig. 2 Caliper Attachment.

exactly in the center of a punch mark when scribing a circle. When attached to a pair of calipers with the points swiveled to point inward, they may be used for measuring screw threads. A single attachment, as shown in Fig. 2, converts the calipers into a tool for scribing and laying out work, and everything can be accomplished with it that can be done with a pair of regular hermaphrodite calipers. When the attachments are clamped to a steel rod, 3-16 inch in diameter, they make an exceedingly neat and convenient pair of trammels. In Fig. 2 the corresponding parts in the views are lettered alike and the construction is clearly shown. The attachments are nicely finished and are sold at a low price.

ADJUSTABLE WRENCH.

A new wrench, manufactured by Frank G. Davison, 112 Front Street, Brooklyn, N. Y., is shown in the two views below, Fig. 3. The handle of the wrench is made of malleable iron, having a taper hole at the large end, of a rectangular or oblong cross section. This forms a casing or sheath in which fit the two drop-forged steel jaws shown in the lower view. These jaws are adjusted by a thumb screw and it will be

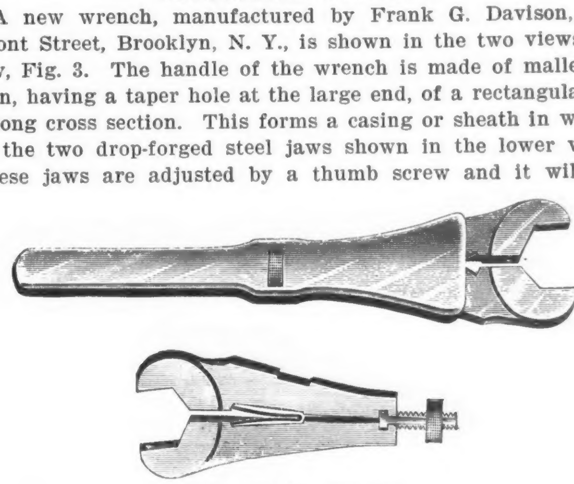


Fig. 3. Davison Wrench.

noted that they are forced apart by a spring and that one jaw is notched on its edge. A pin projects into this notch and forms a stop in each direction. The jaws of the wrench are so proportioned that when they are in their outward position their inner faces will be exactly parallel; and when they are drawn in and closed together, the outer ends of the jaws will be, if anything, slightly nearer together than at the base of the jaws. They will thus always have a firm bearing on the sides of the nut. This wrench is made in three sizes, the smallest having an adjustment of 3-16 inch, the medium 1/4 inch, and the largest 3/8 inch. Inasmuch as the jaws can be adjusted to fit accurately any nut within their range and no strain will alter the adjustment, there is no danger of their slipping and marring the nut on which the wrench is being used

NEW DISK GRINDER.

A disk grinder of new design is shown in Fig. 4. It is manufactured by the Bayldon Machine & Tool Co., 18-20 Morris Street, Jersey City, N. J. It is a powerfully driven grinder, well built, and is sold at a moderate price. It is made in two sizes, with 18 and 23-inch disks, and will finish flat surfaces accurately and cheaply, square, parallel or at angle with one another. A special feature of the machine is the design of the spindle and bearings, which are shown in Fig. 5. The spindle is of a highgrade steel, accurately ground, the faceplate being ground on its face in position. The two sides of the plate are parallel, and the abrasive material may be attached to either. The journals are self-lining and lubricating 5 inches long, 1⅝ inches diameter, and have spirals cut from end to end. The pressure on the disk is taken by a ball thrust bearing. Two styles of tables are furnished, one of which does not move with the work, but is adjustable for height and distance from face of disk; the other has a rocking movement and also tilts, is counterweighted and can be raised or moved out or in from the disk. The machine is made either double or single, with disks on each end of the spindle or on one end only as desired.

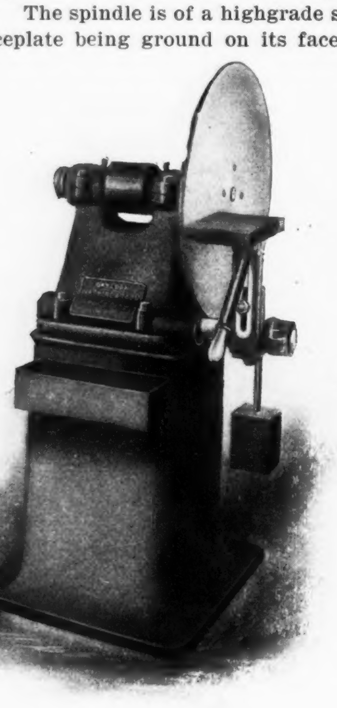


Fig. 4. Bayldon Disk Grinder.

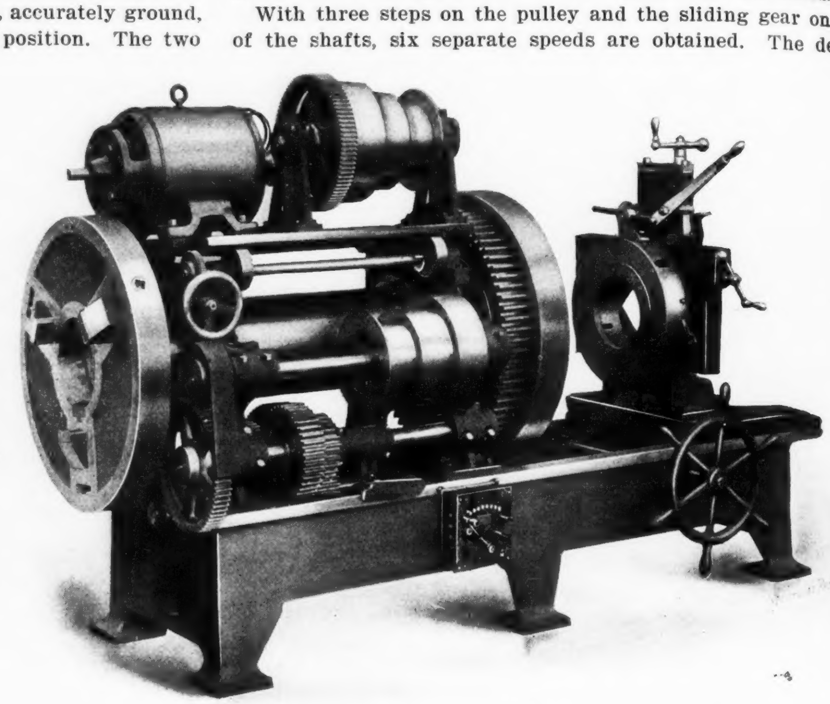


Fig. 6. Bignall & Keeler Electrically Driven Pipe Threading Machine.

APPLICATION OF ELECTRIC MOTOR.

The illustration, Fig. 6, shows the style of electric drive designed by the Bignall and Keeler Mfg. Co., Edwardsville, Ill., for their duplex pipe threading and cutting machines, which are made in sizes for pipe from 6 to 18 inches in diameter.

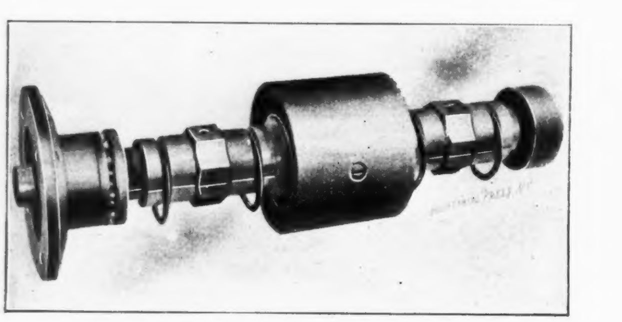


Fig. 5. Spindle and Bearings of Grinder.

It is well known that the method of controlling motor speeds by means of resistance boxes is wasteful and unsatisfactory. With the drive shown the motor runs at constant speed and the speed variation is obtained by cone pulleys and a shifting belt which is a satisfactory method where no multiple voltage or other special system is available. The motor is supported on a table directly over the main bearings of the machine, which also supports a countershaft on which a 3-step cone pulley and a large gear wheel are securely fastened. The motor pinion meshes directly into this gear on the countershaft. One side of the table is supported on a hinged bearing, fitting into one side of the main journal cap, while the other side is supported on two steel cams, as shown. The cam shaft is supported in journals, and the cams may be revolved and the table elevated or lowered by means of a worm and wormwheel. With this cam movement, the belt, which naturally grows loose through wear, can be tightened when necessary.

With three steps on the pulley and the sliding gear on one of the shafts, six separate speeds are obtained. The device for regulating the height of the table and thereby regulating the tension of the belt makes the short belt drive between the cone pulleys quite as effective as if a long belt were used. With this method of driving no increase in floor space is needed; the machine can be placed in practically any shop where belt machines are used, and being self-contained, can be easily moved from one locality to another.

A UNIQUE GRINDER.

In Fig. 7 appears a cut of an electrically-driven grinder which can be used for a wide range of work, such as lathe center grinding, reamer grinding, surface and internal grinding, and is limited only by the size of the lathe in which it is used. The tool is held in the tool post of the lathe by means of a steel shank *B*. This shank can be removed and another of a different size substituted if desired. The grinding of cutters and reamers is accomplished by holding the work between the lathe centers and using the tooth rest attached to the grinder for indexing. Bevel cutters may be ground in a like manner, it being only necessary to adjust the motor to the desired angle. For center grinding the tooth

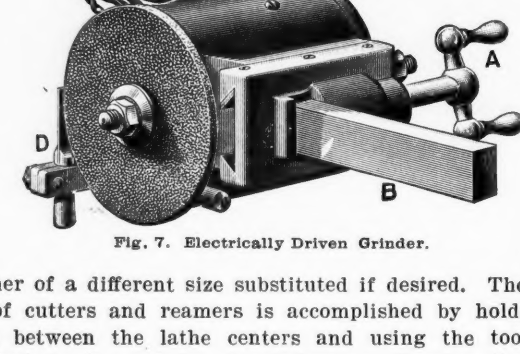


Fig. 7. Electrically Driven Grinder.

rest *D* is removed and the motor is placed at the angle of the center to be ground. The machine has a slide movement of two inches through the handle *A*, and the slides are fitted with a gib to take up the wear. The machine receives current for the motor from the incandescent light circuit of the shop and can be connected to any lamp socket. Internal grinding is accomplished by an extension mandrel furnished as an extra, and the machine will be found very handy for grinding hardened rings and collars. The motor is entirely encased, making it dust-proof, and the bearings are provided with dust-proof caps and are adjustable for wear. The machine is made by the Hisey Machine Works, 77 Elm St., Cincinnati, O.

NEW MACHINISTS' TOOLS.

The illustrations, Figs. 8 and 9, show two tools placed on the market by the Massachusetts Tool Co., Greenfield, Mass. The first of these is a 6-inch micrometer caliper designed for measuring from zero to 6 inches by half thousandths. The sliding micrometer head travels on a cylindrical barrel through which a hole is accurately bored to accommodate three plugs, one, two and three inches long, as in the engraving.

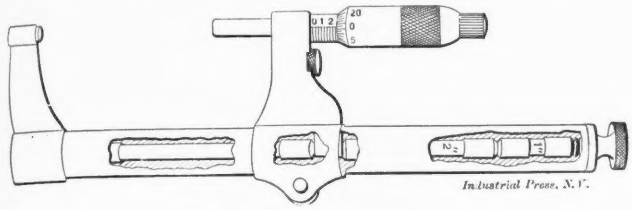


Fig. 8. Six-inch Micrometer.

These plugs serve to locate the traveling head at fixed distances one inch apart. The micrometer screw itself has a travel of one inch, like any standard micrometer. A locknut is used to hold the screw in any desired position. A thumb screw at the end of the barrel bears against the end plug and zero marks are provided to bring the screw against the plug with the same degree of pressure at each setting. When the head is clamped by means of the locking nut, it is as rigid as though it were solid with the barrel, and the faces of the measuring points are thus always parallel.

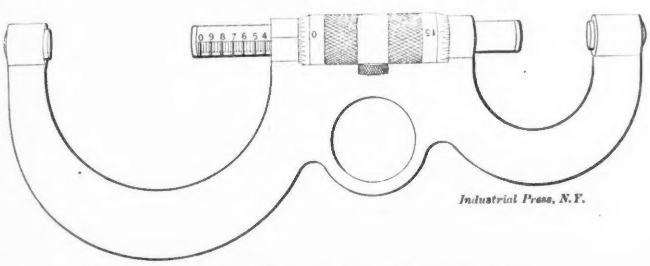


Fig. 9. Combined One and Two-inch Micrometer.

A combined one- and two-inch micrometer is shown in Fig. 9. One side records measurements up to one inch, and the other side up to two inches. A single knurled sleeve or nut serves to move the double-ended measuring piece one way or the other as desired, this piece having a travel of one inch. The spindle is non-rotating, so that the faces of the screw and anvil are always parallel. A locking device holds the screw in any position. This tool is convenient for use both in measuring and as a gage, since it can be conveniently held by the finger ring appearing at the back. A modification of the 6-inch micrometer is made in the form of a 6-inch micrometer surface gage which operates on the same principle.

HEAVY ARBOR PRESS.

A new arbor press has been brought out by Edwin E. Bartlett, Boston, Mass., manufacturer of the Greenerd arbor press, which is of radically different design from the smaller presses previously brought out. The new machine is to be known as the No. 8 Greenerd arbor press. It is powerfully geared with a leverage of 250 to 1, and it is anticipated that a pressure of between 15 and 18 tons will be realized at the end of the ram, with a man of ordinary strength at the lever. The ram is made of a piece of 4-inch crucible steel and has a rack cut on two opposite sides. The gears are all of steel, the smaller being of hardened tool steel. The gears were designed especially for this press by the Brown & Sharpe Mfg. Co. The fact that the force applied at the lever is transmitted to the ram by two sets of gears, one operating in the rack on one side of the ram and the other on the opposite side, gives a powerful and uniform pressure to the ram throughout its whole travel. When the lever is at its lowest position the pawl drops from the ratchet and the

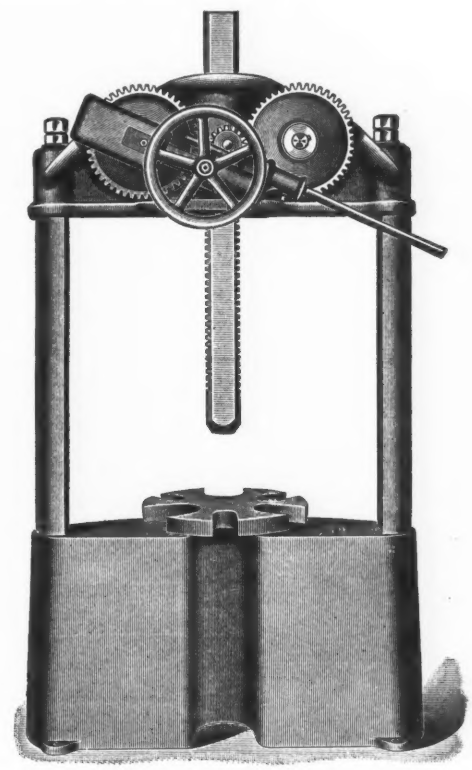


Fig. 10. Greenerd Arbor Press.

ram is free to be moved in either direction by means of the hand wheel shown in front. It will be noted that the sides of the ram are recessed at the ends of the rack teeth, so that the teeth do not bear on the slides in the frame of the machine, which might prove detrimental and cause excessive wear. The press weighs about 2,000 pounds, and is designed for driving arbors up to 7 inches in diameter. There is 36 inches clearance between the uprights, and 35 inches between the plate and the top of the frame.

UNIVERSAL DISK GRINDER.

The accompanying half tone, Fig. 11, illustrates the No. 15 ring universal grinding machine, brought out recently by the George Gorton Machine Co., Racine, Wis. This machine is

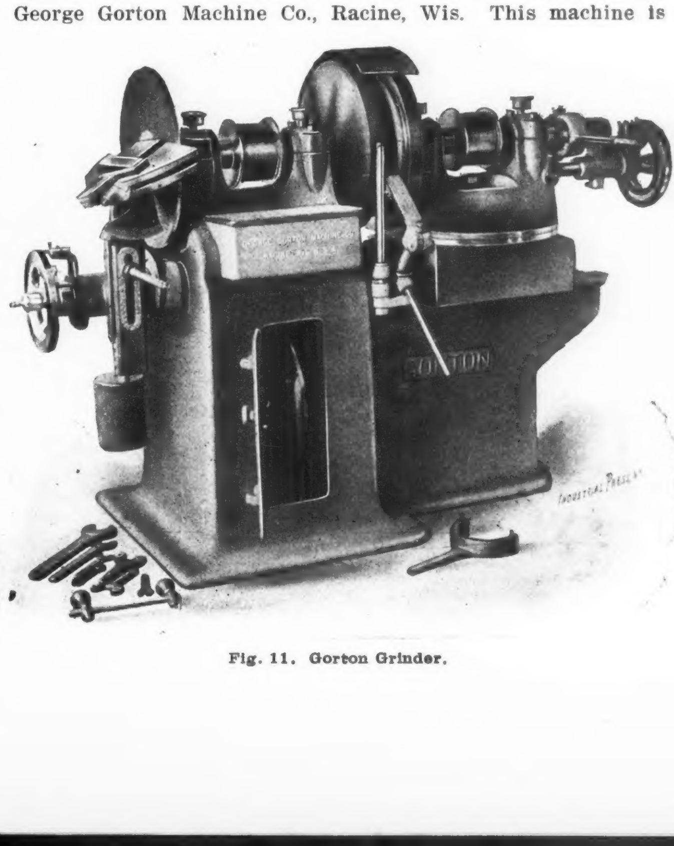


Fig. 11. Gorton Grinder.

equipped with a two-speed countershaft, the highest speed being utilized for operating the steel disks, one of which is shown on the arbor at the extreme left. The slower speed operates the two central chucks which contain 15-inch emery rings designed specially for the finishing from the rough. Two arbors carry the emery rings, and thus parallel surfaces may be produced accurately of interchangeable dimensions, these dimensions being retained by means of the micrometer stop contained at the extreme right of the machine, and adjusted by the handwheel shown, which is graduated in thousandths. The right-hand arbor has an endwise movement of one inch, and is moved to and from the work by the lever shown at the right hand. It is mounted upon a headstock adjustable 30 degrees each way. The swinging tables shown between the two chucks are for special work requiring the passage of the pieces between the emery rings. A diamond point is also provided on this table, for dressing the rings when necessary. The table at the extreme left has angular adjustment—micrometer, graduated in thousandths of an inch, and protractor, registering in degrees. The emery ring chucks open from 0 to 12 inches. These machines are also equipped with 18-inch steel disks throughout instead of the emery rings, for such work as the finishing of brass and for other work not requiring the removal of an excessive amount of scale. The machine complete weighs 3,000 pounds.

MULTIPLE SPINDLE DRILL.

During the past year Foote, Burt & Co., Cleveland, Ohio, have added to their various lines of multiple spindle drills, so that now they are able to furnish any type of multiple drill in almost any size that may be required for both light and heavy work. They manufacture a complete line of sensitive drills, having from two to six spindles and automatic feeds if desired. Their heavier drills have independent feeds for the spindles and will drill holes up to 1½ inch in diameter. In the accompanying illustration, Fig. 12, is one of several styles and sizes of drills having universally adjustable spindles, the machine shown having recently been placed on the market. In this case there are really three independent machines mounted on one base, each group of spindles having from two to five spindles which may be adjusted either in or out from the drill, or longitudinally. This method of adjustment has the merit of great solidity, and by its use it is possible to procure any spacing of holes that may be required. The machine is provided with both treadle and lever feed, has a capacity of 5¼-inch drills in each group, and where less than five spindles are used correspondingly large drills can be employed. The larger machines with universally adjustable spindles will drill 1¼-inch holes.

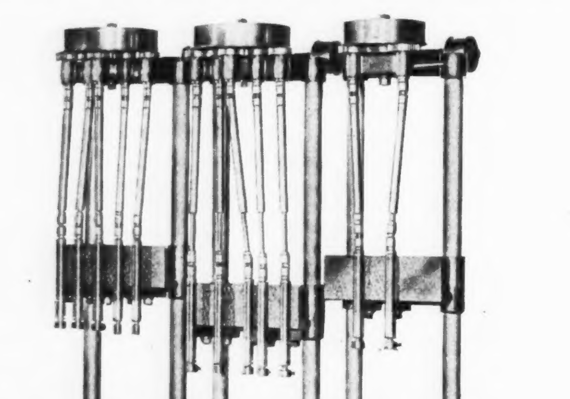


Fig. 12, Universally Adjustable Multiple Drill.

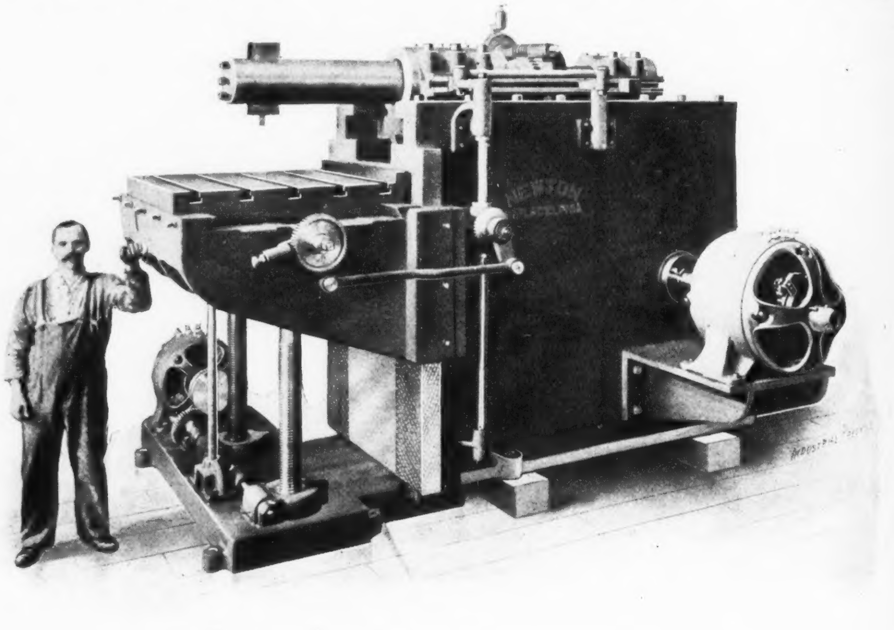


Fig. 13. Newton Shaper of Unusual Dimensions.

HEAVY DRAW-CUT SHAPER.

The Newton Machine Tool Works, Philadelphia, have brought out a shaper which is so heavy and of such massive proportions as to be unusual even for a heavy tool of this description. It weighs about 30,000 pounds and is designed especially for such heavy work as cutting off the risers from steel castings. The machine stands very high from the floor, as is evident by comparison with the man in the engraving, and this allows a corresponding adjustment of the knee.

The design of the shaper is novel throughout. It is electrically driven, two motors being used, one for driving the ram and one for elevating the table and knee. The ram is driven by a Whitworth quick-return motion, and the speed reduction between the motor and this motion is by means of two worms and wormwheels, one worm and wormwheel driving the next pair. The Newton Machine Co. have made a specialty of this form of gearing, which insures its satisfactory operation even in an application of this kind. The shaper cuts during the return stroke, making it peculiarly adapted for heavy work. The body of the ram consists of a horizontal head or carriage sliding in ways, just as in the case of the ordinary shaper. Instead of supporting the tool, however, in a toolpost at the end of this carriage or ram, there is a cutter bar extending outward from the carriage for a considerable distance and the tool is supported at the end of this. One of the chief results gained by this construction is that no matter in what position the ram may be, its ability to resist any upward thrust at the cutting point will always be the same, and hence the deflection of the bar will be uniform throughout the stroke. Theoretically, at least, more accurate work can be obtained in this way because with the usual design of ram the distance between the point of support of the ram and the cutting tool changes for every point of the stroke. So far as we know, however, this shaper is the first to be constructed

on the principle explained above, although such construction has been advocated by a contributor in MACHINERY.

The cutter bar is 9 inches in diameter, which dimension gives an idea of its massiveness and power. The bar has a rotary feed by means of a worm and wormwheel operated by a ratchet movement, adapting the machine to shaping out the field pieces of electric motors and other circular work. This feed, as well as the other usual feeds with which the machine is provided, is automatic. The stroke of the cutter bar is 18 inches.

* * *

HISTORY OF THE COOKING RANGE.

Josiah M. Read, the inventor of a cooking range and a manufacturer of stoves, died at Boston, Mass., November 7, 1901, at the age of 92 years. Mr. Read began the manufacture of stoves in Boston in 1839, and invented his cooking range in 1846. It has been erroneously stated that he was the originator of the cooking stove or range, whereas he is, in all probability, only an improver of it. There appears to be no authentic record of who was the inventor of the portable airtight stove for domestic use. Isaac Orr, who died in 1844 at the age of 50 years, is said to have been its inventor, but the claim is not well substantiated, and, in fact, is proved untrue by air-tight stoves built as early as 1767. The first cooking stoves were made by an adaptation of a baking oven to the box-stove, such as formerly generally used in schools, churches, etc. Such a cooking stove was made in 1812 at Hudson, N. Y., by a Mr. Hoxie, but it appears that he was not the originator of the idea, as subsequent litigation developed the fact that his patent claim was based on the firebox being above the oven, with a flue to carry the products of combustion downward around the oven. To Gordan L. Mott, of New York, belongs much credit for the development and improvement of stoves. He is said to have been one of the first to successfully use cupola or re-melted iron for stove plates. Previous to this stove plates were made from blast furnace iron, which is, of course, the same as pig iron, and they were consequently very rough and heavy. The reason for using such iron was that no one had been able to use remelted iron successfully on account of the plates cracking from the heat. Mott used cupola iron and got thin, clean castings, which made what were then thought to be elegant stoves. To avoid cracking, the plates were paneled, fluted and curved, which allowed them to expand freely when heated, so that Mott's first success appears to have been more because of design of the plates than because of any radical improvement in the quality of the iron. His first patent on stoves was granted in 1832. Joel Rathbone, Albany, N. Y., was another pioneer in the stove industry, who probably did as much if not more than Mott for the improvement of iron founding. He successfully made light, thin stove castings from cupola iron in 1838. His stoves soon became popular because of their lightness and cheapness, and the business of stove making within a few years grew to great proportions. Bearing on the history of stoves and stove manufacture, the following item, which has appeared recently in a number of publications, is of interest: "A stove is owned by the Michigan Stove Co. which was made in 1767. It is described as an old-fashioned box stove, standing upon legs or end braces similar to those of a sewing machine, only that they are about half as high as the latter and are of much heavier casting. The total weight of the stove is 500 pounds, and the iron from which it is made is seven-eighths of an inch thick in all parts. It is 3 feet long, 34 inches high, and one foot wide, with a hearth extending in front. The only opening on top is a small hole for the pipe. It was evidently used for heating and cooking, although without lids. The oven would hardly accommodate a turkey, even of modest dimensions. It measures 14½ inches in length, 12 inches in width, and 6 in height. The floor of the oven is removable, thus making greater heating capacity. There is no grate in the bottom, the fire being built directly on the bottom of the stove, the heat passing from below the oven, back of it and over the top to the pipe. The outside has scroll designs and crowns in relief, much after the fashion of stoves to-day, and on both sides cast with the metal are the words: 'Hereford Furnace, Thomas Maybury, Manufacturer, 1767.' The stove is well preserved in spite of its almost 150 years of age. Thomas Maybury was a pioneer iron manufacturer in Pennsylvania and New Jersey in the 18th century. Hereford Furnace was one of his enterprises. It was located in the Schuylkill Valley, Pennsylvania, and was in existence and active as late as 1788. Mr. Maybury was himself a man of much prominence."

* * *

Reuleaux defines a machine as a combination of resistant bodies so arranged that by their means the mechanical forces of nature can be compelled to do work accompanied by certain determinate motions; and a machine tool, as a "form-changing" machine. The latter definition does not appear quite complete in view of common acceptance of the term "machine tool" since a wood planer is a "form-changing" machine, but certainly it is not a machine tool. A more complete definition might be: "A machine tool is a form-changing machine for working metals."

* * *

We are informed by the Blair Machine Tool Works, 24-27 West St., New York, that the fixture for milling lag screw threads described in the last number of MACHINERY was designed by their superintendent, Mr. J. A. Webster. We are glad to give credit for the design, as the device was of unusual interest and showed much originality in its design.

* * *

ADVERTISING LITERATURE.

We have received the following catalogues and trade circulars:

THE TURNER, VAUGHN & TAYLOR CO., Cuyahoga Falls, O. Catalogue of chain machinery which includes the new Edgecombe hammer that has recently been placed on the market.

THE B. F. STURTEVANT CO., Boston, Mass. Illustrated circular of the Sturtevant forges, including the down-draft forge with adjustable hood. Forges for both heavy and small work are shown.

THE F. E. REED CO., Worcester, Mass. 1902 catalogue of engine lathes, speed lathes, chucking lathes, etc. The lathes made by this company are too well known to need further mention. A new machine illustrated in this catalogue is a rack cutter, which is semi-automatic in its operation. A spindle drilling lathe is also shown.

THE GOODELL-PRATT CO., Greenfield, Mass. Catalogue No. 5 of small tools for machinists, carpenters and others. This company make a great variety of automatic hand and breast drills, for drilling metal and wood and automatic screw drivers. They also make several styles of bench drills, for amateur and machinists' use. Their list of tools includes also their hack saws, polishing heads, belt clamps, etc.

THE MASSACHUSETTS TOOL CO., Greenfield, Mass. Illustrated catalogue of machinists' tools and small model bench lathes. The tools listed include a line of micrometer calipers and several special calipers for inside and outside measuring, two of which are illustrated in another part of this issue. There are also surface gages, protractors, trammels and other tools. This company have purchased the mechanical tool business of Coffin & Leighton, Syracuse, N. Y., and will continue the manufacture of scales which this latter company formerly made.

THE CINCINNATI PLANER CO., Cincinnati, O. Catalogue of the standard line of planers made by this company. These are made in sizes ranging from 24 to 60 inches. They include both belt and electrically driven machines, the latter having the motor mounted on top of the housings, from which point power is transmitted by belts to the pulleys at the base of the machines. There are also shown widened planers, which have the uprights further apart in proportion to the height than the standard machines, and the bed is also widened on each side a corresponding amount. This is to accommodate work where extreme height is not required.

MANUFACTURERS' NOTES.

THE BALL BEARING CO., Boston, Mass., have sold out to Manning, Maxwell & Moore, but will continue to do business under the old name.

THE BURT MFG. CO., Akron, Ohio, have recently received an order from the De Beers Consolidated Mining Co., Ltd., of Kimberley, South Africa, for a very large Cross oil filter to be used in their new power house.

THE business formerly carried on by Perry Ransom, Oshkosh, Wis., has just been purchased by the Ransom Mfg. Co., with capital stock of $25,000. The new company will carry on business on about the same lines as heretofore.

M. A. HUDSON and H. S. Whitney, formerly connected with one of the largest machinery supply houses in New York, are representing in New York and vicinity the Standard Gage Mfg. Co., Syracuse, N. Y.; J. E. Lonergan & Co., Philadelphia, Pa., and the Penberthy Injector Co., Detroit, Mich. They have offices at 141 Broadway.

THE BICKFORD DRILL & TOOL CO., Cincinnati, O., have recently added to their plant a three-story building on the corner of Pike and Front Sts., to be used for their general offices, drafting rooms pattern shop, and also as a show room for their tools. The room which this addition releases in the main works is badly needed for manufacturing purposes.

THE REEVES PULLEY CO., Columbus, Ind., manufacturers of the "Reeves" variable speed transmission, report a healthy condition of trade in this branch of their factory, the large number of orders recently booked making it necessary to operate this department 13 to 14 hours per day. The paper industry has opened up an unlimited field for the application of the larger sizes, and for the handling of these massive machines the company have built quite an extensive addition to their works.

THE R. A. KELLY CO., Xenia, O., manufacturers of shapers, have bought the large plant of the National Cordage Co., which adjoins their own, and will use the main building for the manufacture of shapers and the remainder for a needed addition to their cordage works. The machine shop has been located some distance from their main works, and a considerable saving of time and expense will be effected by this purchase, as well as additional room secured for the lack of which their shaper business has been suffering.